

**A reactive *in-situ* crystallisation origin for the UG2 Chromitite of the
Bushveld Complex, South Africa?**

Victoria Scoging

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Department of Earth and Environmental Sciences
Faculty of Science
University of Ottawa



uOttawa

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Abstract

The UG2 Chromitite of the ~2 Ga Bushveld Complex (South Africa) is one of the largest platinum-group element (PGE) deposits on Earth. It is ~1 m thick and can be traced for virtually the entire circumference of the eastern and western lobes of the Bushveld. Despite its economic importance and a plethora of studies devoted to understanding its petrogenesis, there is no consensus on how the UG2 body formed. Models invoking fractional crystallisation, *in-situ* crystallisation, gravity settling within crystal-rich slurries and crustal contamination have all been proposed. Recent studies on chromitite formation in other layered intrusions have demonstrated significant mineral chemical and textural disequilibrium features associated with chromitite layers, attributed to a reactive origin for these bodies. This study aims to evaluate if reaction between incoming magma and anorthositic footwall may have triggered crystallisation of some or all of the massive UG2 Chromitite. Specifically, we focus on microtextural variations at the mm-to-cm-scale across silicate to massive chromitite contacts in the UG2 and associated leader seam from a drill core sampled on the Magazynskraal farm in the western lobe of the Bushveld intrusion. We have carried out petrographic analysis and quantitative textural approaches including crystal size distribution (CSD), dihedral angle measurements, as well as mineral chemical and *in-situ* $^{87}\text{Sr}/^{86}\text{Sr}$ laser ablation inductively coupled-plasma mass spectrometry (LA-ICPMS) in plagioclase samples leading up and into the base of the UG2 Chromitite. We also studied materials at the contacts of the overlying leader seam. Petrographic observations reveal disequilibrium textural relationships in the footwall pyroxenite; e.g., chromite is typically separated from orthopyroxene by thin (μm -scale) rims of plagioclase. Interstitial plagioclase is chemically zoned and the anorthite content of the plagioclase shows consistent increases (e.g., An_{58} to An_{92}) near chromite. CSD analysis yields mainly log-linear plots suggesting *in-situ* crystallisation with some evidence for postcumulus textural modification. Apparent chromite-chromite-plagioclase dihedral angle measurements reveal median values (for a given ~1 cm thick interval) of $65\text{--}75^\circ$ and suggest that textural equilibrium has not been achieved. The $^{87}\text{Sr}/^{86}\text{Sr}$ variability points to the interaction between isotopically distinct signatures at the postcumulus stage. Our combined observations suggest disequilibrium between mineral phases and reactive (dissolution-reprecipitation) crystallisation in the UG2 Chromitite crystal mush.

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Statement of Research Contributions

Results from this thesis are currently in preparation for submission to the *Journal of Petrology* as a multi-author manuscript. Victoria Scoging wrote all of the text presented here, drafted all of the figures and performed all of the quantitative textural measurements and mineral chemical analysis. Victoria Scoging also collated the datasets and made the primary interpretations. Dr. Brian O'Driscoll helped with the formulation of ideas, edited several drafts of the text and advised on figure content and construction. Dr. O'Driscoll's grants funded the mineral chemical and Sr isotope work presented. Additional contributions were from Glenn Poirier in standardising the electron microprobe before analysis and helping to reduce the data, Dr. Graham Pearson at the University of Alberta who carried out Sr isotope LA-ICPMS analysis and reduced these data and Dr. Marian Holness for offering advice on interpreting dihedral angle variations.

1. Introduction

Base and precious metal minerals, notably chromite and PGM (platinum-group minerals), are economically significant and in high demand due to their importance in applications across a wide range of scientific and industrial activity. The geological bodies hosting the greatest supply of these particular metals are chromitites within layered mafic-ultramafic intrusions (Schoenberg et al. 1999; Spandler et al. 2005; Cawthorn 2005; Latypov et al. 2015; Veksler et al. 2018; Hepworth et al. 2020). Chromitites are cumulate rocks mineralogically dominated by the presence of chromite (>60 vol.%) and intercumulus silicate (Mondal & Mathez 2007; O'Driscoll et al. 2014). Renowned layered mafic-ultramafic intrusions that contain chromitite layers include the Stillwater Complex (USA; Campbell et al. 1983; Spandler et al. 2005; Hunt et al. 2021; Marsh et al. 2021), the Rum layered intrusion (Holness et al. 2007; O'Driscoll et al. 2010; O'Driscoll et al. 2014; Hepworth et al. 2020; Hunt et al. 2021), the Muskox intrusion (Canada; Irvine 1977; Hunt et al. 2021) and the Bushveld Complex (Eales et al. 1988; Kinnaird et al. 2002; Cawthorn 2005; Mathez & Mey 2005; Mondal & Mathez 2007; Naldrett et al. 2009; Junge et al. 2014; Vukmanovic et al. 2013; Latypov et al. 2015; Maier et al. 2016; Mungall et al. 2016; Latypov et al. 2017; Veksler et al. 2018; Kaufmann et al. 2018; Langa et al. 2021; Scoates et al. 2021; Latypov et al. 2022; Holness et al. 2023; Latypov et al. 2023; Latypov et al. 2024; Maier & Barnes 2024). Of these bodies, the ~2.05 Ga Bushveld Complex in South Africa is the world's largest known layered intrusion and is famous for its multitude of layers of massive chromite (Naldrett et al. 2009; Junge et al. 2014; Scoates et al. 2021; Latypov et al. 2022). The Bushveld intrusion is the world's largest repository for chromium, platinum-group elements (PGE), magnetite, vanadium and titanium (Kinnaird et al. 2002).

Despite the economic significance of layered intrusion chromitites, there is a fundamental lack of understanding regarding the mechanics of their formation (Mondal & Mathez 2007; Junge et al. 2014; Latypov et al. 2015; Latypov et al. 2017; Veksler et al. 2018; Hepworth et al. 2020; Marsh et al. 2021; Latypov et al. 2023; Latypov et al. 2024). These uncertainties are not helped by the broader, contradictory predictions for the emplacement of layered intrusions themselves prior to their crystallisation in the crust. Some workers argue that layered intrusions represent 'big-tank' magma chambers (Fig. 1.1A, Latypov et al. 2015) whereas others interpret layered intrusions as incrementally constructed sill-like bodies, in which new magma emplacement may have occurred into previously formed cumulates (Fig. 1.1B, Mungall et al. 2016; Hepworth et al. 2020).

In the classic 'big-tank' chamber model, there is a traditional view that the layering of chromitites is the result of gravity settling from a basaltic melt column (Latypov et al. 2017). Recent studies have refuted the idea of gravity settling citing in particular field observations that include chromitite layers draping irregular footwall topography, including overhangs (O'Driscoll et al. 2014; Latypov et al. 2017; Kaufmann et al. 2018; Latypov et al. 2024). Other workers (e.g., Latypov et al. 2017) highlight the mass balance problem; a typical basaltic magma only contains 100-300 ppm of chromium and, therefore, cannot easily account for the substantial volume of massive chromitite.

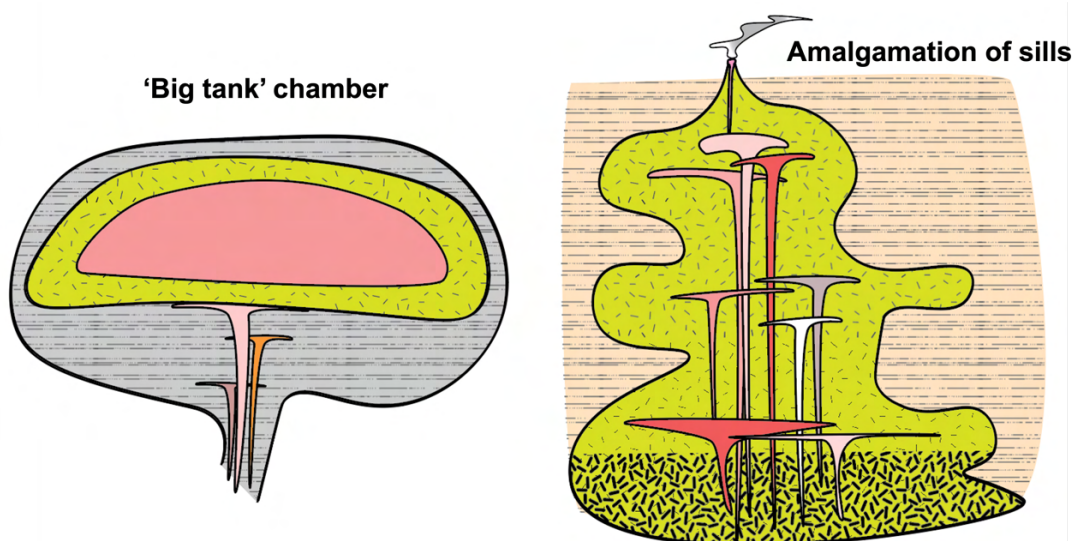


Figure 1.1. Schematic sketches showing the types of geometries predicted for layered intrusions. (A) A traditional ‘big-tank’ chamber. (B) An amalgamation of sills in a cumulate mush. This figure is based on that presented in Cashman et al. (2017).

In response to these issues, models involving magma mixing (Eales et al. 1988; Schoenberg et al. 1999; Kinnaird et al. 2002; Spandler et al. 2005; O’Driscoll et al. 2014) and pressure changes (Latypov et al. 2015) have been proposed as drivers for chromite saturation in magma (O’Driscoll et al. 2014; Latypov et al. 2017; Kaufmann et al. 2018; Latypov et al. 2024). *In-situ* crystallisation, instead of gravity settling, has also been proposed to account for discordant basal chromitite contacts (O’Driscoll et al. 2014; Latypov et al. 2017). There is a general consensus that the Bushveld Complex must have been constructed by multiple pulses of magma (Latypov et al. 2017; Kaufmann et al. 2018), and it was recognised that repeated influxes led to the system having difficulty achieving physical, thermal and chemical equilibrium (Eales et al. 1988; Naldrett et al. 2009; Latypov et al. 2015). The idea of reaction between incoming melt and preexisting cumulate as a driver for chromite crystallisation has been proposed previously for chromitite formation in the Bushveld intrusion (Scoon & Costin 2018), as well as the Rum layered intrusion (O’Driscoll et al. 2010; Hepworth et al. 2020).

This study aims to elucidate the formation mechanisms responsible for creating the massive UG2 Chromitite in the Bushveld Complex, South Africa. Specifically, we examine a core section through the chromitite to search for evidence of mineral chemical and microstructural disequilibrium, which might in turn shed light on the crystallisation and postcumulus evolution of the UG2 body. We focus on the silicate-rich centimeter-scale stratigraphy immediately below, within and above the UG2 Chromitite in our core sample MZK130-D2 from the western lobe in the Bushveld Complex. A combination of quantitative and qualitative analyses including petrographic observations, crystal size distribution (CSD), apparent dihedral angles, electron microprobe analysis and element mapping as well as *in-situ* laser ablation inductively coupled plasma mass spectrometer (LA-ICPMS) plagioclase Sr isotope measurements, have all been carried out. Recognising that the UG2 chromitite is a laterally extensive (100s km) and complex rock unit that exhibits considerable textural and lithological heterogeneity at different locations in the Bushveld, the combined data shed new light on the

solidification history of the UG2 Chromitite, at least for this particular part of the Bushveld intrusion. Specifically, important outcomes of our work are the new observations reported for open system behaviour of the UG2 chromite mush after accumulation.

2. Formation of Massive Chromitites in Layered Intrusions

2.1 An overview of massive chromitite formation in layered intrusions

The formation of massive stratiform chromitites in layered mafic-ultramafic intrusions has attracted significant research attention and is the basis for ongoing lively debate amongst igneous petrologists and ore geologists (e.g., Mathez & Mey 2005; Mondal & Mathez 2007; Junge et al. 2014; Latypov et al. 2015; Latypov et al. 2017; Veksler et al. 2018; Hepworth et al. 2020; Robb & Mungall 2020; Marsh et al. 2021; Latypov et al. 2023; Latypov et al. 2024). Massive chromitites have been distinguished from sub-cm thick reaction-type chromitite seams and ophiolite-hosted podiform chromitites by Mathez and Kinzler (2017), and it was suggested in the latter review article that massive chromitite must form by some process of primary accumulation; however, there is still no agreement on precisely what mechanism is responsible for producing the decimeter-to-metre thick chromitites such as those observed in the Critical Zone of the Bushveld Complex or the Peridotite Zone of the Stillwater Complex. It remains possible that no single model can entirely explain the formation of massive chromitite in the Bushveld Complex but the most popular ideas in the recent literature include variations on the themes of (1) magma mixing with subsequent gravitational settling of chromite (Eales et al. 1988; Kinnaird et al. 2002; Spandler et al. 2005; O'Driscoll et al. 2014), (2) *in-situ* crystallisation (O'Driscoll et al. 2014; Latypov et al. 2017; Kaufmann et al. 2018; Latypov et al. 2024), (3) crystallisation of a magma already saturated in chromite (Kaufmann et al. 2018; Latypov et al. 2022; Latypov et al. 2024) and (4) emplacement of pulses of crystal (chromite)-rich slurries (Fig. 2.1.1, Mondal & Mathez 2007; Maier et al. 2016; Jenkins & Mungall 2018; Yao et al. 2021; Maier & Barnes 2024). The development of this debate has distilled the different models into the central question of whether the chromite forming the massive chromitite crystallised within the intrusion or was transported as a crystal cargo from depth. In order to provide context for the present study, each of these broad models for chromitite formation is briefly summarised below; however, other posited triggers for chromite crystallisation, such as fO_2 fluctuations in the parental magma (Cawthorn 2005), are not discussed further.

2.2 Crystal Settling

Most layered mafic intrusions are considered to differentiate by open-system magmatic differentiation (O'Driscoll et al. 2010; Junge et al. 2014; Latypov et al. 2015; O'Driscoll & VanTongeren 2017; Latypov et al. 2024). Gravitational settling of crystals, driven by density differences at the crystal-liquid interface, is the classic mechanism to explain layering of cumulate rocks (cf. Wager et al. 1960; Wager & Brown 1968). The key issue that any model for chromitite formation has to address is that of mass balance – how can so much Cr (in excess of 45 wt.% Cr_2O_3) be fixed at the point of chromitite formation when typical basalt magmas contain only several hundreds of ppm of Cr (Latypov et al. 2017). Even in the case where high Cr komatiites have been suggested as parental melts to the Bushveld Complex (Eales & Costin

2012), highly efficient processes of concentrating the chromite are still necessitated. In the case of the UG2 Chromitite, an important connection has been made between the repetitive layering of massive chromite and the fractional crystallisation of multiple magma replenishments (Eales et al. 1988; Kinnaird et al. 2002; Spandler et al. 2005). Crystal settling of chromite from each new magma pulse is plausible because the density of chromite greatly exceeds that of basalt melt (Campbell et al. 1983; Naldrett et al. 1987). In the crystal settling group of models, a trigger is within the magma chamber is then required for chromite saturation in the magma.

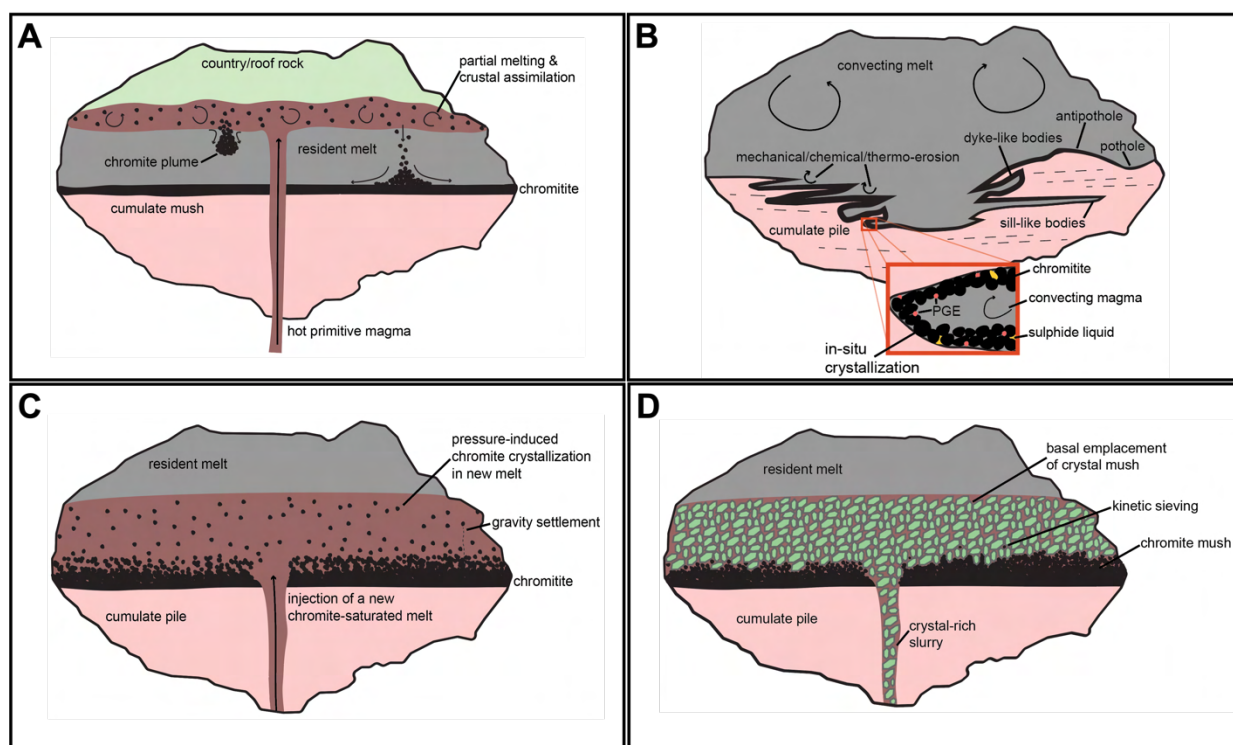


Figure 2.1.1. Illustration of the main models for the formation of massive chromitites. (A) Magma mixing: hot, primitive melt mixes with country roof rock by partial melting and assimilation (Eales et al. 1988; Kinnaird et al. 2002; Spandler et al. 2005). Abundant chromite crystallisation in the hybrid melt may settle by gravity as either individual crystals or chromite plumes (e.g., Spandler et al. 2005); (B) *In-situ* crystallisation: strong convective stirring of the resident melt or input of new primitive melt causes the mechanical and/or thermochemical erosion of the cumulate floor (Eales et al. 1988; Naldrett et al. 2009; Latypov et al. 2015). The cumulate floor preserves evidence of such erosion as antipotholes, potholes and sill-/dyke-like bodies in the footwall (Eales et al. 1988; Latypov et al. 2015; Maier et al. 2016). Unconformable chromitite forms along the irregular cumulate floor by *in-situ* crystallisation (Latypov et al. 2015; Latypov et al. 2017); (C) Chromite-saturated melt: magma pulses of an already chromite-saturated melt are injected into the chamber (Latypov et al. 2015; Latypov et al. 2017; Kaufmann et al. 2018). Pressure-induced chromite-crystallisation occurs in suspension of new melt and settles to cumulate floor (Latypov et al. 2015). (D) Crystal-rich slurries: basal emplacement of a crystal-rich slurry containing orthopyroxene and chromite in suspension (Mondal & Mathez 2007; Maier et al. 2016; Maier & Barnes 2024). Kinetic sieving may then separate chromite mush from pyroxenite (Mondal & Mathez 2007; Maier et al. 2016; Mungall et al. 2016; Jenkins & Mungall 2018; Yao et al. 2021).

During new injection of primitive melt in an open magmatic system, it is likely that magma mixing between the new and resident magma would occur (Irvine 1975; Irvine 1977; Kinnaird et al. 2002; Spandler et al. 2005). Such a process was originally invoked as a means to saturate magma in chromite, because of the curvature of the olivine-chromite cotectic (Irvine 1977; Naldrett et al. 2009). Crystallisation in suspension and subsequent settling of chromite as a result of ‘mixing’ or the interaction between incoming magma and host country rock (i.e., crustal assimilation) have been proposed (Fig. 2.1.1A; Kinnaird et al. 2002; Spandler et al. 2005). In particular, Spandler et al. (2005) proposed that crustal assimilation by injecting melt may be a catalyst for chromite saturation and the subsequent gravity-controlled settling of chromitite plumes (Fig. 2.1.1A) would have therefore resulted in layers of chromitite forming on top of the preexisting cumulate mush in the Peridotite Zone of the Stillwater Complex.

2.3 In-situ Crystallisation

2.3.1 Infiltration metasomatic replacement

In layered intrusion terminology, *in-situ* crystallisation usually refers to the nucleation and growth of crystals within a boundary layer in close proximity to the crystal mush-melt interface (e.g., O’Driscoll & VanTongeren 2017). *In-situ* crystallisation models for the formation of massive chromite have been developed because of field relations and textural observations in some examples do not support gravity settling processes. For example, unconformable massive chromitite layers line topographic irregularities such as potholes and antipotholes, without necessarily changing thickness (Fig. 2.1.1B, Eales et al. 1988; Latypov et al. 2015; Latypov et al. 2023). These topographic irregularities have been interpreted as a result of either mechanical, chemical, and/or thermomagmatic erosion of the cumulate floor (Eales et al. 1988; Maier et al. 2016). The resulting dissolution and assimilation of existing crystal mush or solid cumulate is seen as a likely trigger to saturate the magma in chromite (Fig. 2.1.1B; Spandler et al. 2005; Hepworth et al. 2020). *In-situ* crystallisation of chromitite has thus been explained as a consequence of reaction between incoming melt and the existing crystal mush (Scoon & Teigler 1994; O’Driscoll et al. 2010; Latypov et al. 2015; Maier et al. 2016; Scoon & Costin 2018; Hepworth et al. 2020). In a variant of this model, it has been suggested by some workers that reaction of incoming melt and preexisting cumulate need not happen at the putative chamber floor; instead intrusive emplacement and throughflow of new magma into the cumulate pile can also satisfy the Cr mass balance problem and form reaction chromitites in a lateral infiltration metasomatism type process (Mathez & Kinzler 2017; Hepworth et al. 2020).

2.3.2 Chromite-saturated melt

It has been suggested in several recent studies that there need not be a trigger for chromite crystallisation within the system where the massive chromitites are found. Instead, *in-situ* crystallisation of a magma already saturated in chromite is believed to have occurred (Fig. 2.1.1C; Latypov et al. 2017; Kaufmann et al. 2018; Latypov et al. 2022; Latypov et al. 2023; Latypov et al. 2024). In these models, the saturation of chromite is the result of a lithostatic drop

in pressure during the ascent of a basaltic melt that pauses in the field of chromite stability (Latypov et al. 2017; Latypov et al. 2018; Latypov et al. 2024). Pressure-induced chromite crystallisation may undergo adcumulus growth without being obstructed by any co-crystallizing silicate phases (Fig. 2.1.1C, Cawthorn 2005; Latypov et al. 2024). The most recently presented field evidence that has been linked to such a model are the magmatic dropstones of Latypov et al. (2024). Here, a magma chamber is cooling along the walls and floor, crystallizing chromite *in-situ* (Latypov et al. 2024). Tectonic activity breaks off fragments of roof cumulate which settle by gravity into an underlying and stratigraphically upward-growing cumulate pile (Latypov et al. 2024).

2.4 Crystal Slurry

The UG2 in the Bushveld Complex is a prime example of a stratiform massive chromitite body in a layered mafic intrusion for which the slurry model has been proposed by several researchers. A partially molten magma is often referred to as a crystal slurry (i.e., a dynamic crystal-rich magma; Latypov et al. 2023). A crystal-rich slurry may be emplaced as a basal layer, i.e., at the magma-crystal mush interface (Fig. 2.1.1D), or as an intrusive sill-like injection (Mondal & Mathez 2007; Maier et al. 2013; Mungall et al. 2016; Robb & Mungall, 2020; Yao et al. 2021). One scenario where this has been considered relevant to massive chromitite formation is where flowing crystal slurries mechanically separate distinct silicate layers from chromitite by kinetic sieving (Fig. 2.1.1D; Mondal & Mathez 2007; Maier et al. 2016; Mungall et al. 2016; Jenkins & Mungall 2018; Yao et al. 2021; Latypov et al. 2023). This argument has been made on the basis of the enormous lateral extent and knife sharp upper and lower contacts between massive chromitite and its hanging/footwall rocks (Maier et al. 2016). Mondal & Mathez (2007), on the basis of chromite abundances, proposed that batches of new magma from a deeper crystallizing chamber injected the Bushveld magma chamber with chromite crystals in suspension. The crystal slurry model is attractive because it also solves the Cr mass balance problem, although it remains uncertain what exactly the triggers for chromite saturation at depth. One suggestion that Cr saturation comes from the contamination of the parental (komatiitic) magma by crustal material (Eales et al. 1988; Eales & Costin, 2012; Mungall et al. 2016). Furthermore, field relationships suggest that the thin leader seams associated with UG2 formed as bifurcations after accumulation but while the rocks were still partially molten, i.e., as crystal slurries (Mungall et al. 2016; Latypov et al. 2017; Mathez & Kinzler 2017; Jenkins & Mungall 2018).

3. Geological Setting

3.1 Overview and Geology of the Bushveld Complex

The Paleoproterozoic Bushveld Complex contains the largest known layered mafic intrusion in the world, covering a surficial area of ~240 km by ~400 km (total area >66,000 km²) with an overall thickness of ≥9 km (Eales & Cawthorn 1996; Kinnaird et al. 2002; Naldrett et al. 2009; Veksler et al. 2018; Latypov et al. 2022). The mafic-ultramafic layered suite, termed the Rustenburg Layered Suite (RLS), has been dated to 2055-2060 Ma (Eales & Cawthorn 1996;

Kinnaird et al. 2002; Mungall et al. 2016; Veksler et al. 2018; Kaufmann et al. 2018; Scoates et al. 2021). The RLS is composed of five lobes, including the far-western, western, eastern and northern lobes that have been purported to be connected at depth by a central feeder chamber (Kinnaird et al. 2002; Karykowski et al. 2018). The fifth lobe is interpreted based on geophysical data to be at depth (Kinnaird et al. 2002; Naldrett et al. 2009; Kaufmann et al. 2018). The RLS is capped by the Rashoop granophyre suite and late Lebowa granites (Kinnaird et al. 2002; Naldrett et al. 2009).

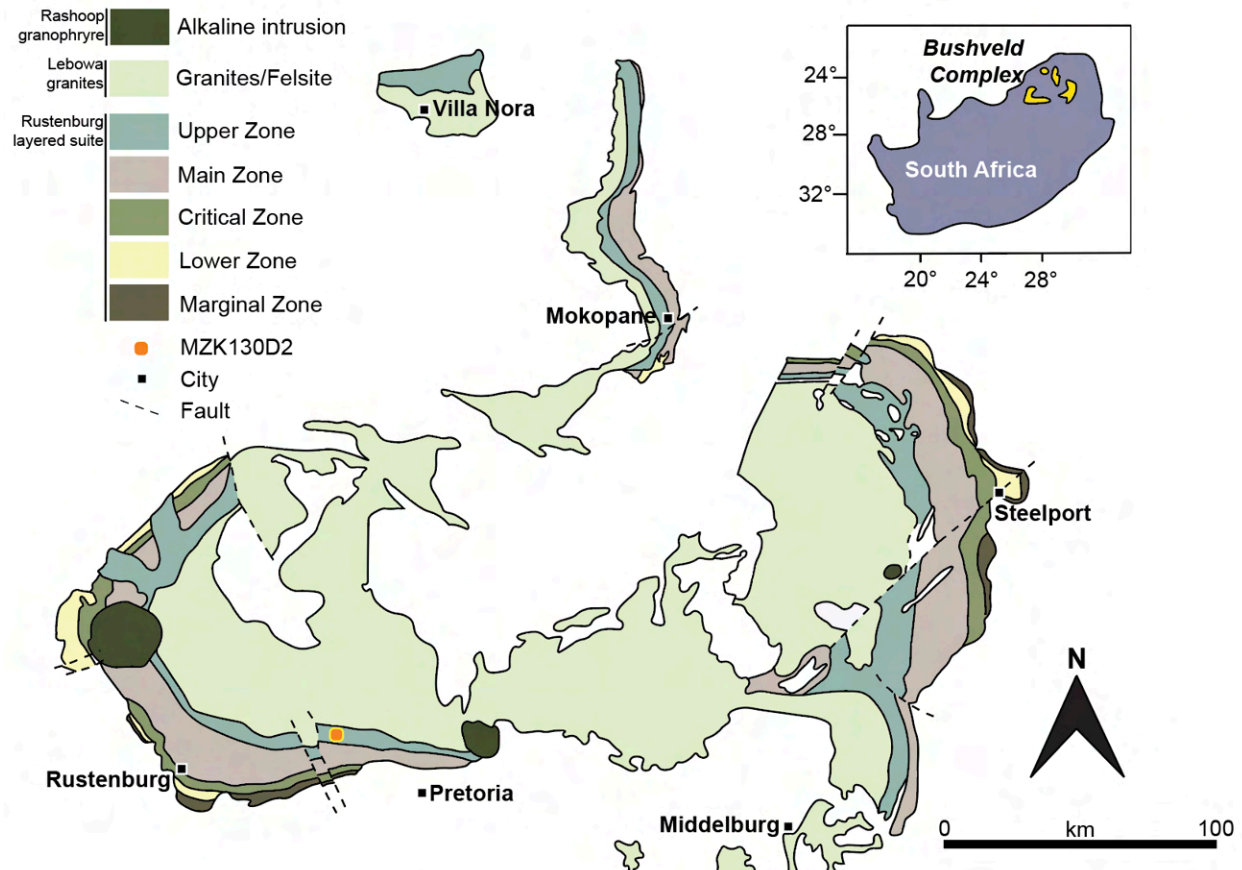


Figure 3.1.1. Geological map of the Bushveld Complex, South Africa. MZK130-D2 marks the location of drill core sample studied here. This map is adapted from that presented by Latypov et al. 2022.

The RLS is divided into several stratigraphic zones that are broadly distinguished by lithological variations considered to reflect major changes in the replenishment behaviour of the magmatic system (Fig. 3.1.2; Kinnaird et al. 2002; Veksler et al. 2018). From bottom to top, these zones comprise the Marginal Zone (mainly heterogeneous norite), the Lower Zone (mainly dunites, pyroxenite, harzburgites), the Critical Zone (chromitites, harzburgites, orthopyroxenites, norites, anorthosites), the Main Zone (mainly norites, gabbronorites) and the Upper Zone (gabbronorites, augite-diorites with magnetite and nelsonite layers) (Kinnaird et al. 2002; Naldrett et al. 2009; Kaufmann et al. 2018; Latypov et al. 2022). The exact physical boundaries between zones vary from one part of the intrusion to another; however, they are generally drawn

based on mineralogical changes from magmatic differentiation or isotopic signatures (Kinnaird et al. 2002). The most significant base and precious metal reserves of the Bushveld Complex are hosted in the PGE-chromitites of the Critical Zone, as well as the magnetitites of the Upper Zone (Kinnaird et al. 2002; Naldrett et al. 2009; Latypov et al. 2023).

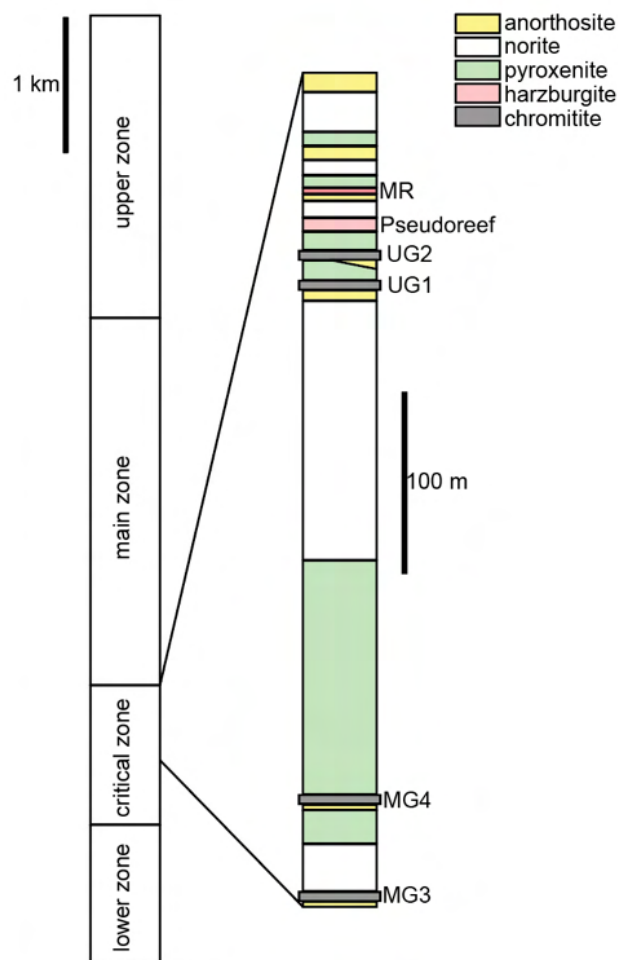


Figure 3.1.2. Stratigraphic column for the Rustenburg Layered Suite with estimated maximum stratigraphic thicknesses of the major zonal subdivisions. The column to the right illustrates the approximate location of subgroups making up the stratigraphy of the Upper Critical Zone. This schematic section is based on that provided in Maier & Barnes (2024), with additional information provided in Kinnaird et al. (2002), Mondal & Mathez (2007) and Cawthorn (2015).

The Critical Zone has an estimated maximum thickness of 800-1000 m (Kinnaird et al. 2002; Kaufmann et al. 2018). Three groups (lower, middle and upper) make up the layers of the Critical Zone. Each contains several stratigraphic members (Kinnaird et al. 2002; Naldrett et al. 2009; Kaufmann et al. 2018; Latypov et al. 2022), as follows: Lower Group (LG1-7, chromitite, ultramafics principally containing successions of cumulate orthopyroxenite); Middle Group (MG1-4, mainly comprising anorthosite, chromitite) and Upper Group (UG1-3, chromitite, harzburgite, pyroxenite, norite, anorthosite). The Middle Group is characterized by the lowermost anorthosite layer marking the onset of cumulus plagioclase crystallisation in the RLS (Kinnaird et al. 2002; Veksler et al. 2018). The chromitite layers of the Critical Zone are

characterised by lateral continuity around the entirety of the intrusion (Junge et al. 2014; Veksler et al. 2018). Overall, the concentration of the PGE increases up stratigraphy (Naldrett et al. 2009; Veksler et al. 2018; Kaufmann et al. 2018).

The single unit containing the world's largest PGE reserve is the massive UG2 Chromitite (Schouwstra et al. 2000). The UG2 Chromitite has rather variable thickness across the complex ranging from 0.15-2.5 m which the chromite abundance is typically ~60-90 mod.% (Junge et al. 2014; Veksler et al. 2018). The footwall and hanging wall to the UG2 Chromitite have highly variable mineralogies and textures around the circumference of the intrusion (Mondal & Mathez 2007). The footwall to the UG2 Chromitite generally consists of anorthosite with variable thickness across the complex (Scoon & Teigler 1994; Veksler et al. 2018). In some localities the anorthosite is only millimetres thick between the UG2 chromitite and pegmatoidal orthopyroxenite. However, other authors (e.g., Veksler et al. 2018; Robb & Mungall 2020) have identified meter thick anorthosite adjacent to UG2. The UG2 footwall has very irregular topography (i.e., potholes) and pegmatitic orthopyroxene-anorthosite autoliths in the lower part of the massive chromitite are observed (Maier et al. 2016). In contrast, the hanging wall consists of (locally) relatively weakly-sheared harzburgite (Mondal & Mathez 2007; Junge et al. 2014). The top of the UG2 Chromitite has been interpreted to bifurcate into smaller subsidiary seams in the adjacent (hanging wall) cumulate rock as so-called 'leader seams' (Naldrett et al. 2009; Junge et al. 2014; Maier et al. 2016; Veksler et al. 2018).

The UG3 massive chromitite locally stratigraphically overlies UG2. Similar to UG2, UG3 is reported to host anorthosite autoliths (Maier et al. 2016) but it locally bifurcates and merges into the top of the UG2 layer where it is recognised as part of the UG2 package as a thinner leader seam (Maier et al. 2016; Veksler et al. 2018; Holness et al. 2023). Above the massive UG2 and UG3 chromitite layers, chromite occurs only as an accessory mineral, disseminated throughout the cumulates, or as mm- to cm-thin stringers in the hanging wall silicate rocks (Veksler et al. 2018).

3.2 *MZK130-D2* Core Description and Sample Provenance

The core section forming the basis for this study was drilled in the western lobe of the Bushveld Complex at the Magazynskraal Farm 3 JQ, about 10 km northwest of Moroleng, North West Province, South Africa. A continuous set of thin sections from the bottom to the top of has been made for the MZK130-D2 core (Fig. 3.2.1). The footwall immediately underneath the chromitite comprises a cm-thick anorthosite lens. Underlying the anorthosite is pegmatoidal orthopyroxenite (~70 mod. % orthopyroxene), described in this position by many authors (e.g., Maier et al. 2016; Veksler et al. 2018). The orthopyroxene is mainly embedded in interstitial plagioclase and disseminated chromite is visible around the orthopyroxene crystals. The contact between the anorthosite and the orthopyroxenite is characterised by a distinct cone-like structure of chromitite, connected at its top to the base of the massive chromitite, and which passes through the anorthosite and diffusely into the orthopyroxenite (Fig. 3.2.1A).

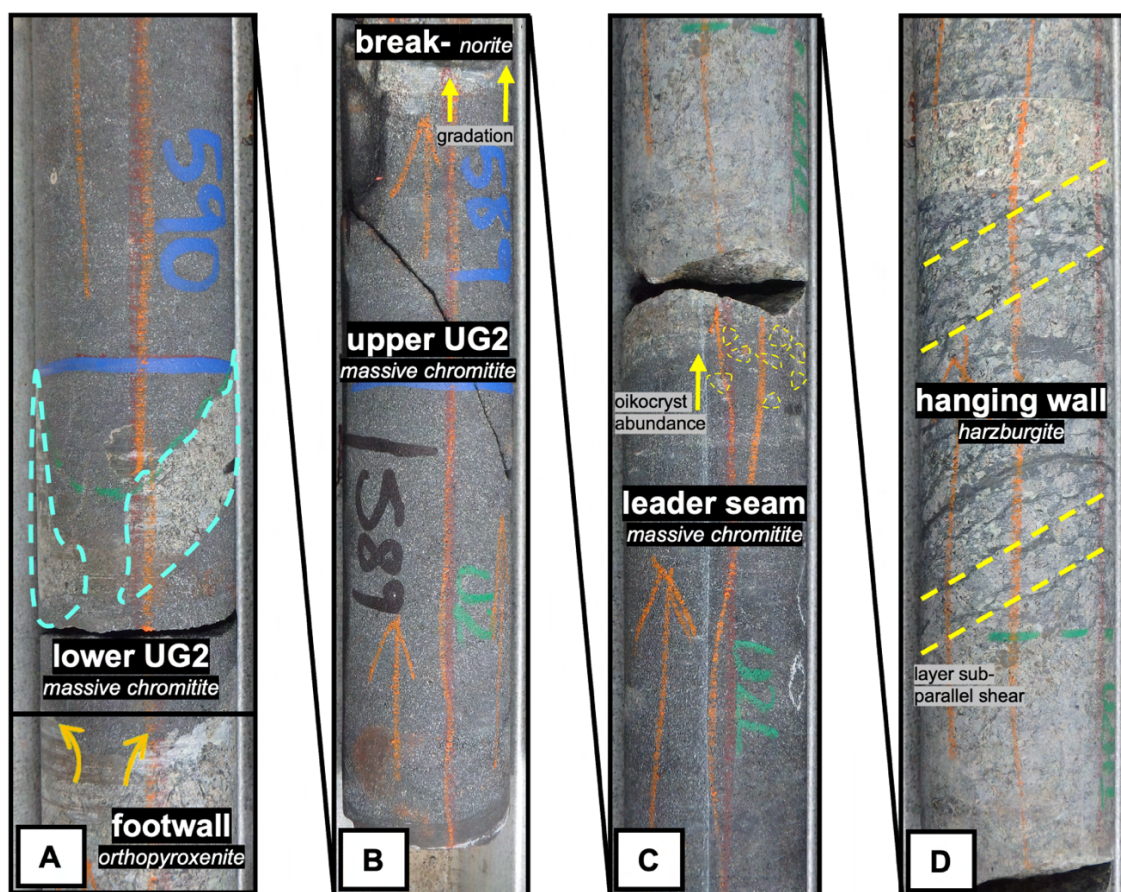


Figure 3.2.1. Photos of core sample MZK130-D2 showing the contact between (A) the footwall and lower UG2, (B) the upper UG2 and the norite break, (C) the leader seam and the hanging wall harzburgite (D). Note in (A) there are yellow arrows indicating the cone-like structure of chromite and blue dotted outlines of autoliths, with the anorthosite lens visible to the right of the yellow arrow on the right, (B) a chromite gradation into the norite break, (C) an increased abundance of oikocrysts making the transition from the leader seam into the hanging wall harzburgite and (D) the dotted yellow lines representing localised layer sub-parallel shearing.

In the massive chromitite of the UG2 layer, a framework of chromite is hosted in interstitial plagioclase in which the ratio of chromite:plagioclase is approximately 60:40. The uppermost part of the massive UG2 Chromitite gradationally transitions to norite (Fig. 3.2.1B). In the norite, there is significantly less chromite, which occurs in clusters around the edges of orthopyroxene grains. The norite break is ~10 cm thick. Above the norite is another ~15 cm thick package of chromitite, referred to as the leader seam, which as noted above has been interpreted by some authors as a bifurcation of UG3 (Maier et al. 2016; Mungall et al. 2016).

The transition from the leader seam to the hanging wall harzburgite occurs over a ~2 cm thick layer containing oikocrystic orthopyroxene (Fig. 3.2.2C). The hanging wall harzburgite shows localised contact sub-parallel shearing (Fig. 3.2.2D). Disseminated chromite occurs along the boundaries of orthopyroxene crystals.

We prioritized analysing samples from the contacts (ex., footwall/massive UG2 Chromitite, massive UG2 chromite/pyroxenite break, pyroxenite break/leader seam, and leader seam/hanging wall) because we hypothesise that evidence for disequilibrium processes should be most pronounced at the boundaries of distinct lithologic sequences. The thin section samples taken from the MZK130-D2 core have been categorized into 5 groups based on their relative position through the UG2 sequence (Fig. 3.2.2): footwall rocks (1.2 and 1.6), lower massive chromitite (2.1 & 2.2), upper massive chromitite (7.2 & 8), leader seam chromitite (9.2, 9.3, 9.4) and hanging wall rocks (10.3). The transitions across the footwall contact, the UG2-norite break contact and the leader seam were studied with subsets of thin sections that come from no more than ~1 cm from one another (Fig. 3.2.2). Thin sections through the middle massive chromitite were also studied for comparison, but at lower spatial resolution (i.e., at ~35 cm intervals; 3.1, 3.11 & 6.3).

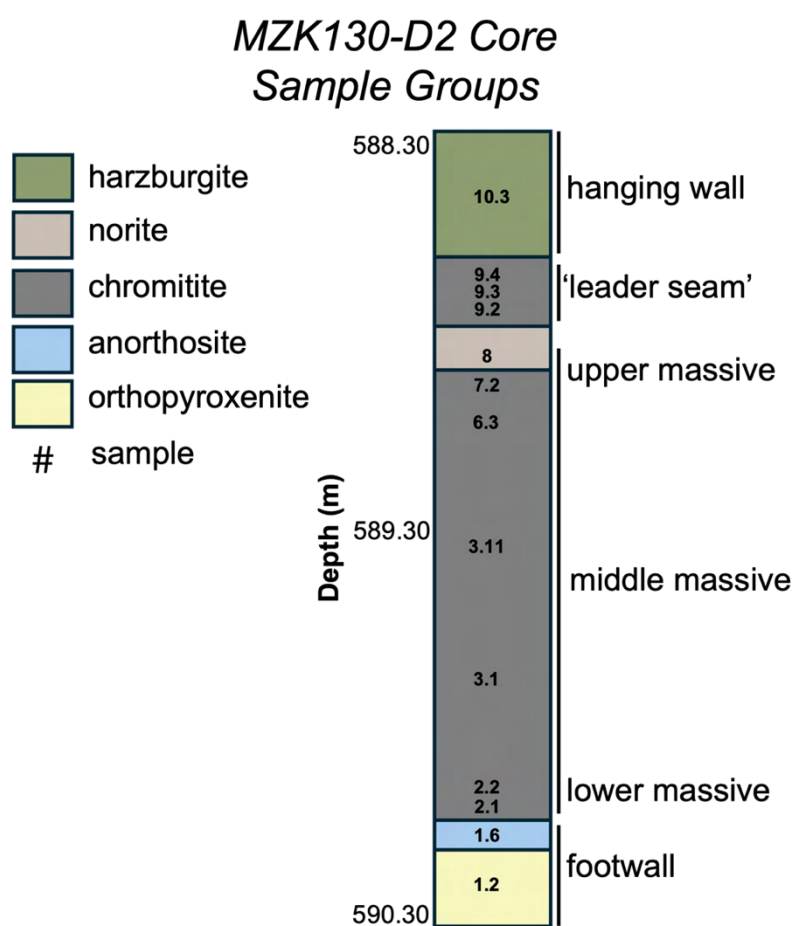


Figure 3.2.2. Simplified stratigraphy of the UG2 in core sample MZK130-D2 shown in Figure 3.2.1. The samples studied have been grouped based on their relative position and lithology (footwall, lower massive, middle massive, upper massive, leader seam and hanging wall). Each number on the column represents a thin section studied. Sample 1.2 and 1.6 are collectively assigned to the footwall group.

4. Mineralogical and microstructural observations

4.1 Footwall Contact and Lower Massive Chromitite

Orthopyroxene comprising 60% modal abundance (mod.%) is euhedral in the footwall norite and exhibits a grain size gradient whereby the grain diameter increases from ~1 mm to ~1 cm with proximity to the base of the massive chromitite. Orthopyroxene immediately below the massive chromitite exhibits a pegmatoidal texture. The main intercumulus phase is plagioclase (30 mod.%). The orthopyroxene crystals contain exsolution lamellae of clinopyroxene. Disseminated chromite crystals are subhedral to euhedral and occur in clusters (Fig. 4.1.1, 4.1.2), that define a ‘chain-like’ distribution around orthopyroxene crystals (Fig. 4.1.1). Where in contact with orthopyroxene, chromite is separated from the latter by a thin rim of interstitial plagioclase (Fig. 4.1.2).

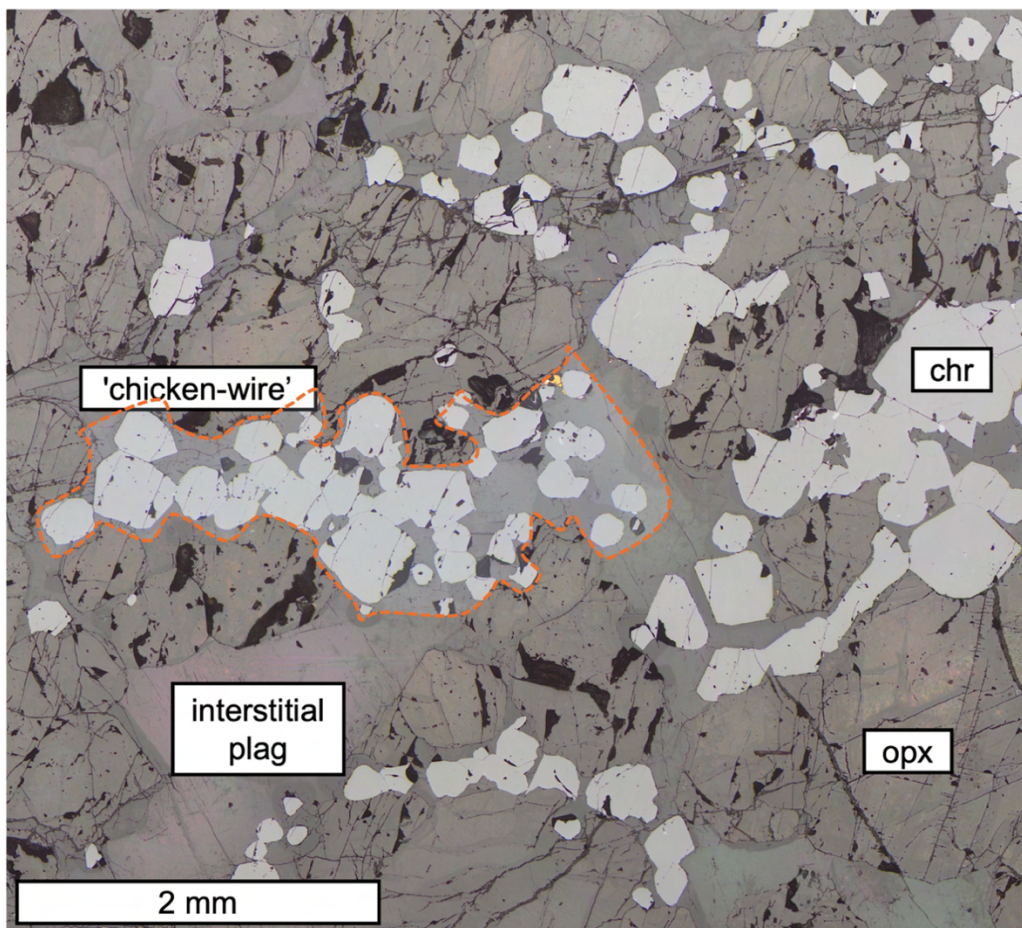


Figure 4.1.1 Reflected light photomicrograph showing chromite crystals surrounding the perimeter of euhedral orthopyroxene grains and forming so-called ‘chicken wire’ texture in the footwall norite (Sample 1.2).

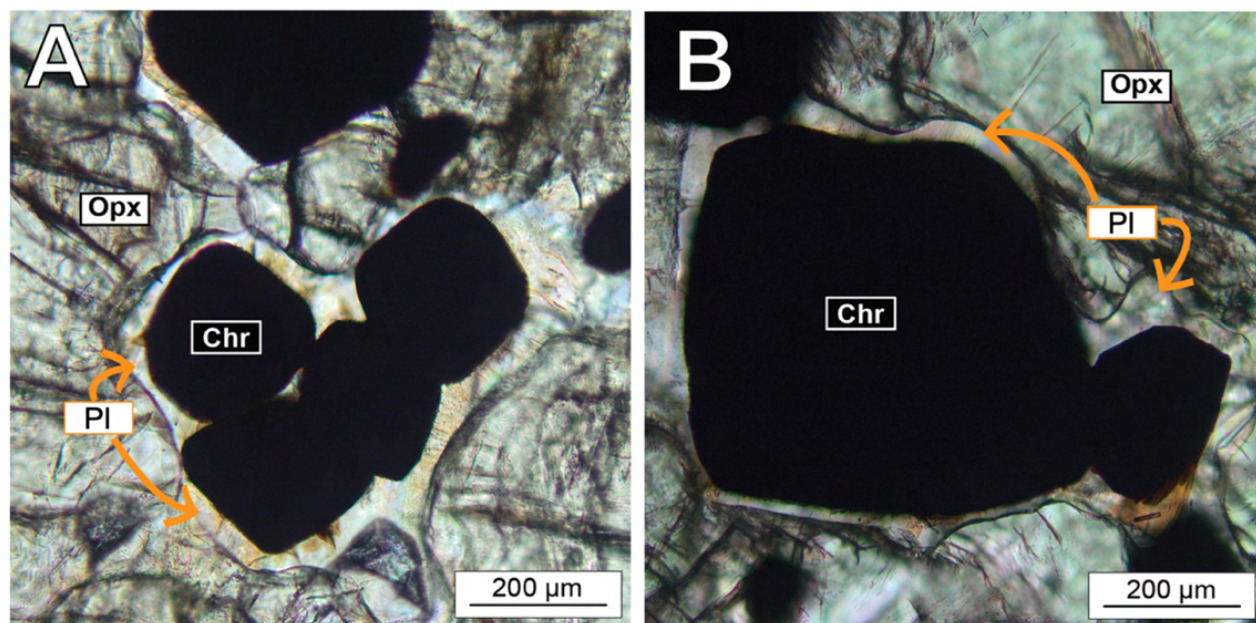


Figure 4.1.2. Both images A (sample 1.5), and B (1.6C) show plagioclase (Pl) rims at the interface between a chromite (Chr) crystal/cluster and orthopyroxene (Opx) under transmitted light.

Intercumulus plagioclase, i.e., in the interstitial spaces between orthopyroxene in the footwall and between chromite in the lower massive chromitite, shows little evidence of hydrous alteration and locally exhibits evidence of optical zoning (Fig. 4.1.3). At the immediate contact between the footwall and the massive chromite, the anorthosite lens is observed to be a single large crystal >3 cm in diameter (labelled Pl in Figure 4.1.4A). Plagioclase locally exhibits evidence for slight alteration (i.e., slight cloudiness along crystallographic planes); however, most of the anorthosite lens consists of fresh plagioclase.

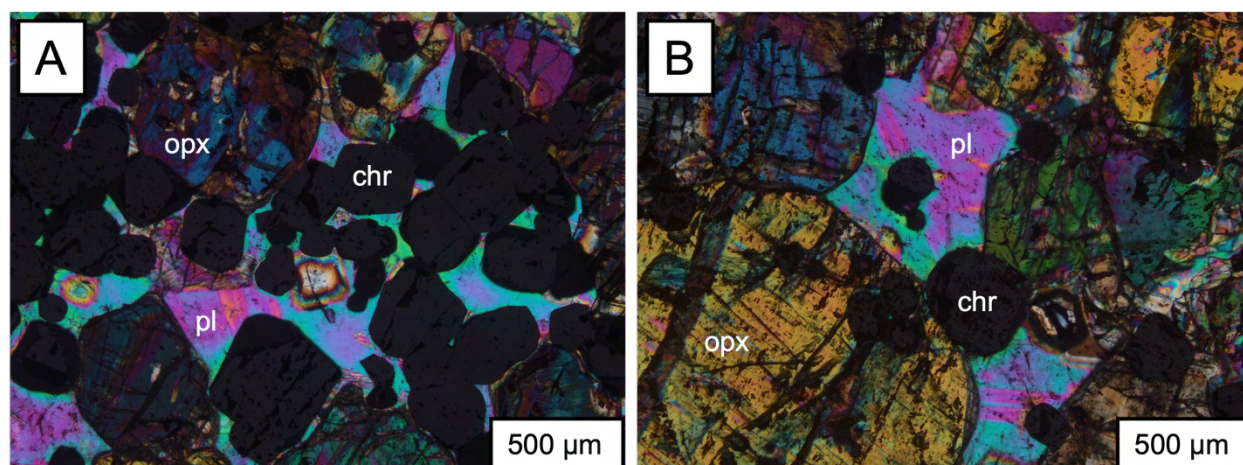


Figure. 4.1.3. Photomicrographs in cross polarized light for sample 1.2 showing optical zoning in intercumulus plagioclase. Note here and in subsequent cross polarised light images, the sections used in this study are cut thick, at $\geq 120 \mu\text{m}$, so interference colours are higher than for typical $30 \mu\text{m}$ thin sections.

Clusters of chromite grains develop within complex and elongate embayments in the orthopyroxene, and extend into the anorthosite as a cone-shaped structure, ~0.5 cm in diameter, culminating in a downward projection of the chromitite boundary (Fig. 4.1.4A). In both the orthopyroxene embayments and the anorthosite, chromite crystals tend to be attached to one another or ‘stacked’, in a manner described by several other authors (Fig. 4.1.4B; e.g., Holness et al. 2023).

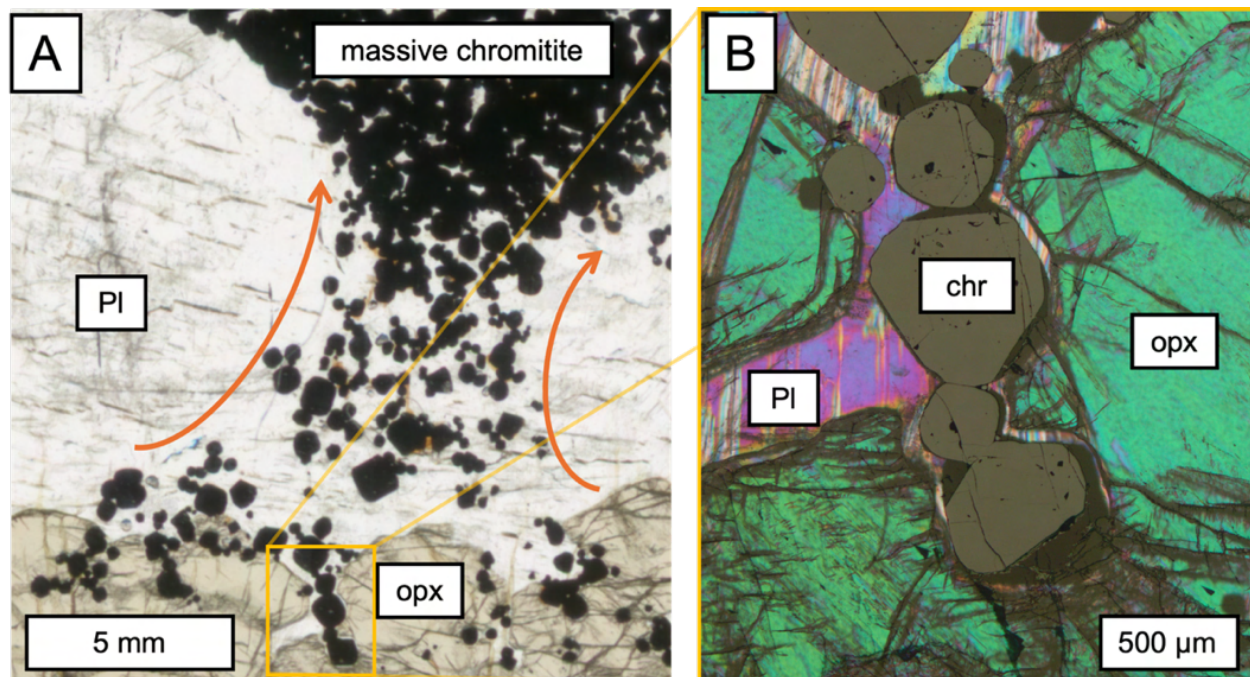


Figure 4.1.4. (A) Thin section scan of the immediate contact between footwall anorthosite and lower massive UG2 Chromitite (Sample 1.6). Orange arrows represent cone-like structure of chromite (chr) grains leading into the massive chromitite. (B) Photomicrograph of chromite stacking in an orthopyroxene (opx) embayment using both reflected and cross polarized light. Note the plagioclase (Pl) rim separating the chromite and orthopyroxene.

Chromite grains across the contact between the footwall anorthosite and the massive chromitite appear to show dissolution-reprecipitation textures (Fig. 4.1.5.). Yudovskaya et al. (2019) has linked these textures local changes in the chemistry of the melt (e.g., temperature, pressure fluctuations). Dissolution surfaces on chromite grains may occur as inter- and/or overgrowths in modes of ‘etch channels’ and ‘fishhooks’ (Yudovskaya et al. 2019). In particular, so-called fishhook textures are ubiquitous in this section of our UG2 core, i.e., across the footwall and lower massive chromitite zone (Fig. 4.1.5). In the lower massive chromitite, elongate, tabular rutile inclusions occur within chromite crystals. Accessory quantities of hydrous phases (biotite, amphibole) and trace sulfides, mainly pyrrhotite, chalcopyrite and pyrite, occur adjacent (and often attached) to chromite, but these phases are not studied further here.

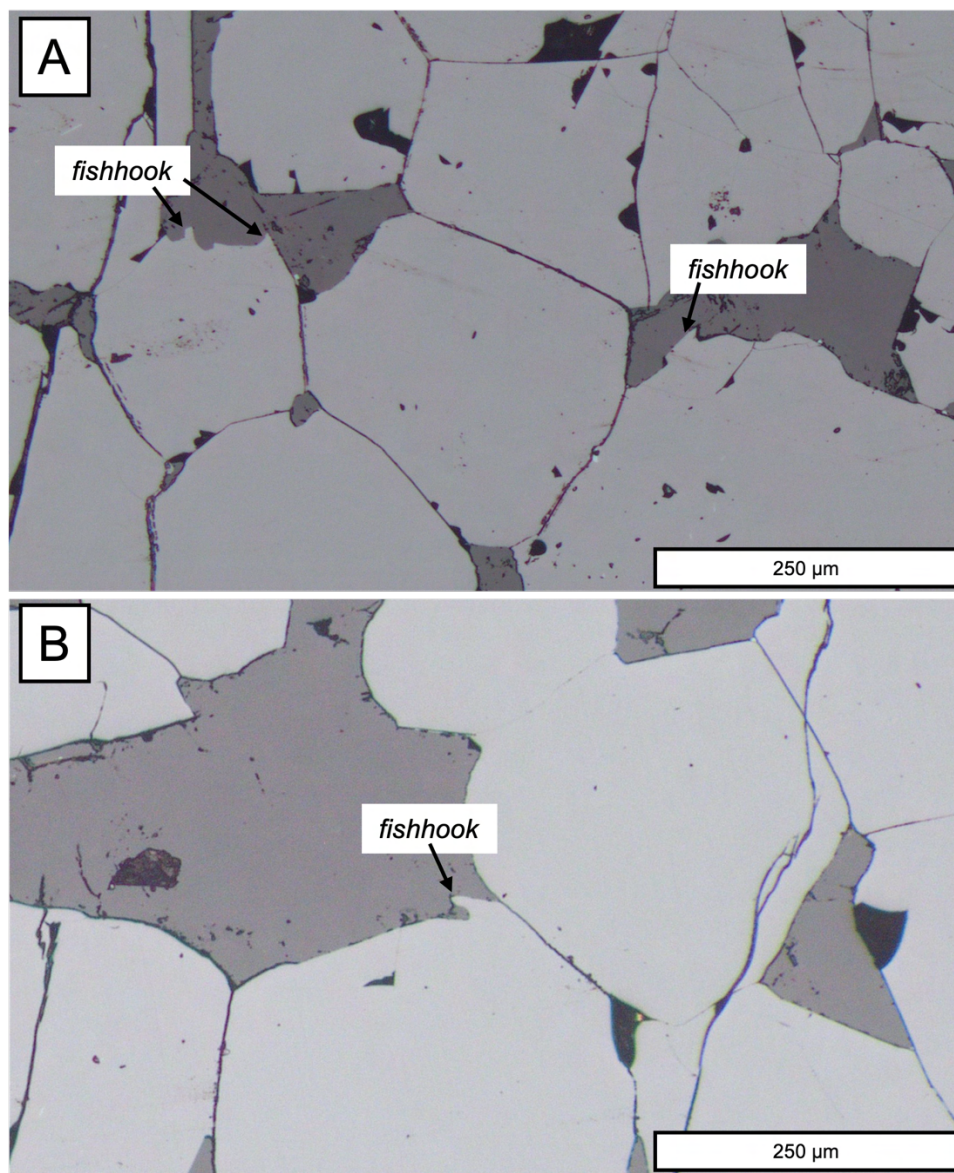


Figure 4.1.5. Photomicrographs illustrating chromite fishhooks in the upper part of the UG2 footwall. (A) Sample 1.2 and (B) Sample 1.6 using reflected light.

Within the first few centimetres of the UG2 Chromitite (lower massive group), there is an orthopyroxene oikocryst, ~1 cm in diameter, containing relatively fine-grained chromite chadacrysts (Fig. 4.1.6A). Also contained within the chromitite at this level and immediately adjacent to oikocryst is a >5 cm diameter autolith, apparently a fragment of the underlying pegmatoidal footwall (Fig. 4.1.6A). The autolith appears undeformed as the grains within exhibit well defined grain boundaries (Fig. 4.1.6A). The orthopyroxene in the autolith contains exsolution lamellae of clinopyroxene and locally-developed, minor areas of serpentine alteration (Fig. 4.1.6A). Trace sulfides (predominantly chalcopyrite) occur with the serpentine alteration. The lowermost part of the UG2 massive chromitite mainly comprises subhedral-euhedral chromite and strongly twinned, locally optically zoned interstitial plagioclase (Fig. 4.1.6B & C).

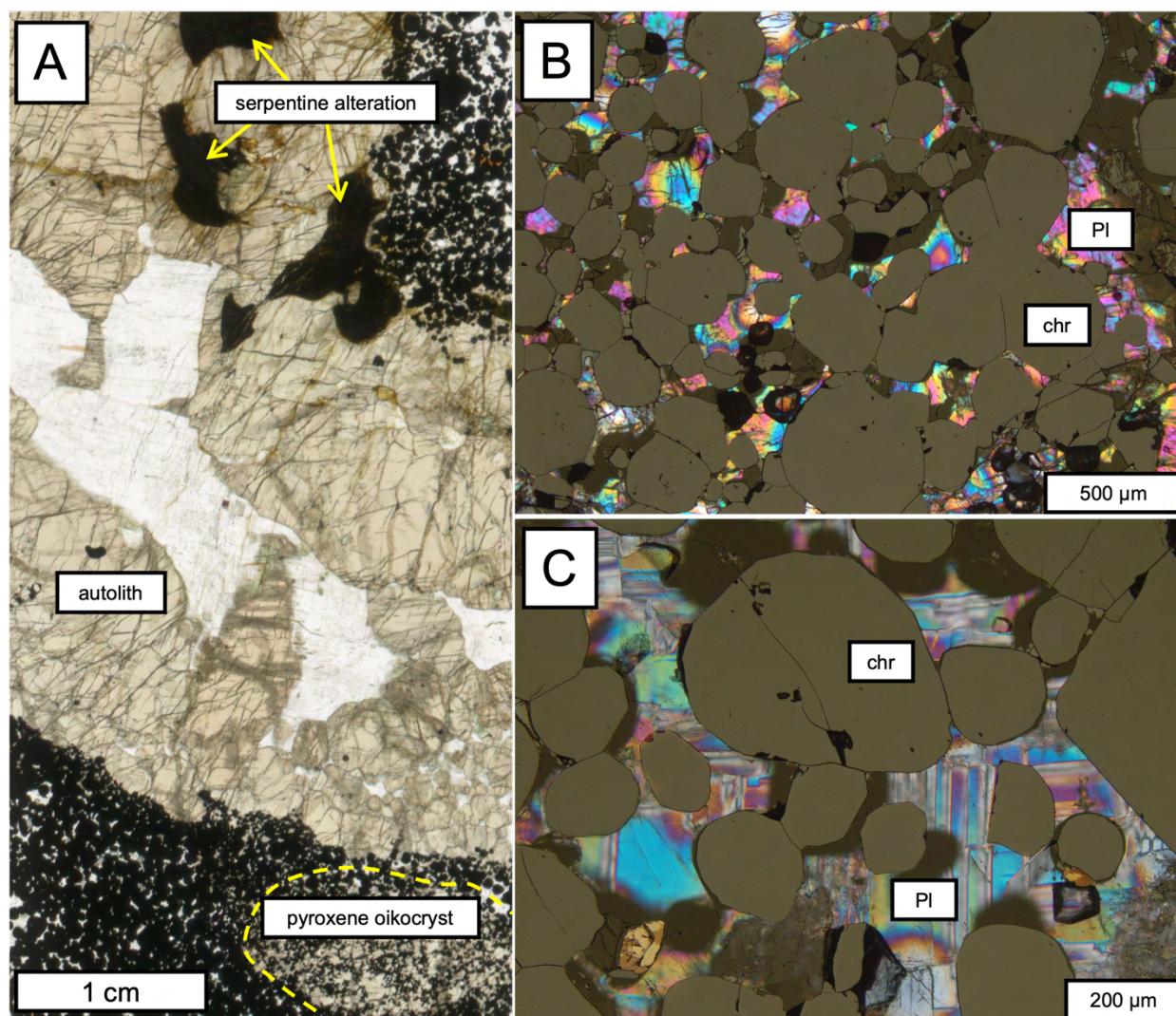


Figure 4.1.6. Sample 2.1 (A) Thin section scan showing orthopyroxene oikocryst adjacent to an autolith within the lower massive UG2 Chromitite. (B and C) Photomicrograph using reflected and cross polarized light showing extensive plagioclase (Pl) twinning in the interstitial spaces between chromite (chr) grains.

The geometry of the dihedral angles between chromite-chromite-plagioclase appear to show some variation across the footwall contact in the MZK130-D2 core sample (Fig. 4.1.7). In the footwall, the junctions are typically faceted whereby the two grain junctions represent the meeting of two planar surfaces (Fig 4.1.7A). The junctions in the lower massive group are often more rounded than those in the footwall and represent instead the meeting of one or two rounded surfaces (Fig. 4.1.7B).

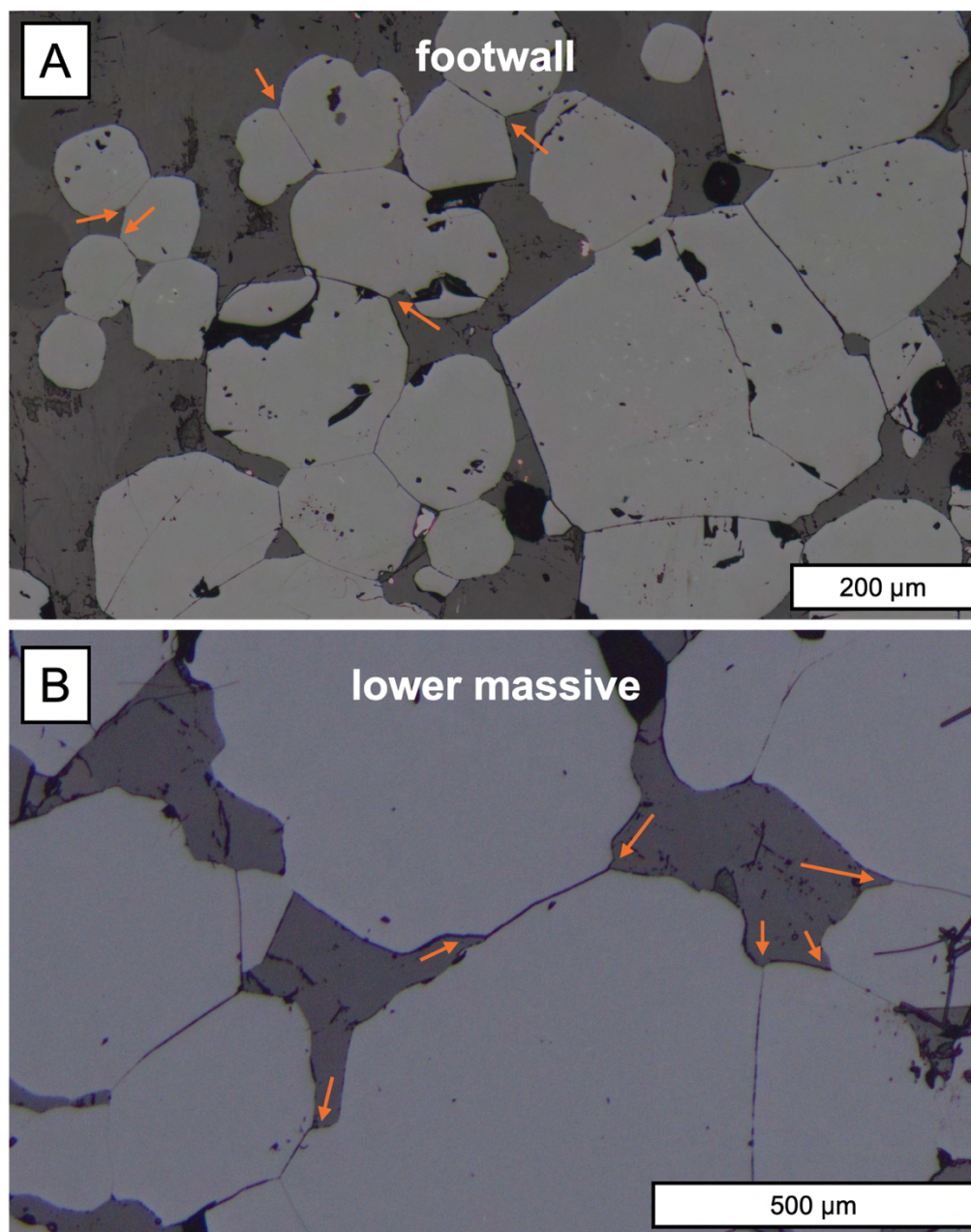


Figure 4.1.7. Photomicrographs taken in reflected light to show dihedral angle junctions (orange arrow) between chromite-chromite-plagioclase for the (A) footwall (Sample 1.6) and (B) lower massive (Sample 2.1).

In the uppermost UG2 Chromitite package, at the base of the pyroxenite that separates the UG2 Chromitite from the overlying leader seam (the ‘norite break’), orthopyroxene oikocrysts host chromite chadacrysts. Plagioclase and orthopyroxene show irregular grain boundaries aligning into a faint foliation. The uppermost ~3 cm of massive chromitite is composed of mainly anhedral chromite crystals that exhibit embayments (Fig. 4.1.8). The transition from upper massive chromitite to the overlying pyroxenite has a very irregular topology, where the chromite grains occur in clusters around relict orthopyroxene grain boundaries (Fig. 4.1.8), in a manner similar to the chain texture described from the footwall. In

other words, this is not a sharply defined planar contact. The transition from upper massive chromitite to pyroxenite is also characterised by a wide grain size range of chromite (Fig. 4.1.8).

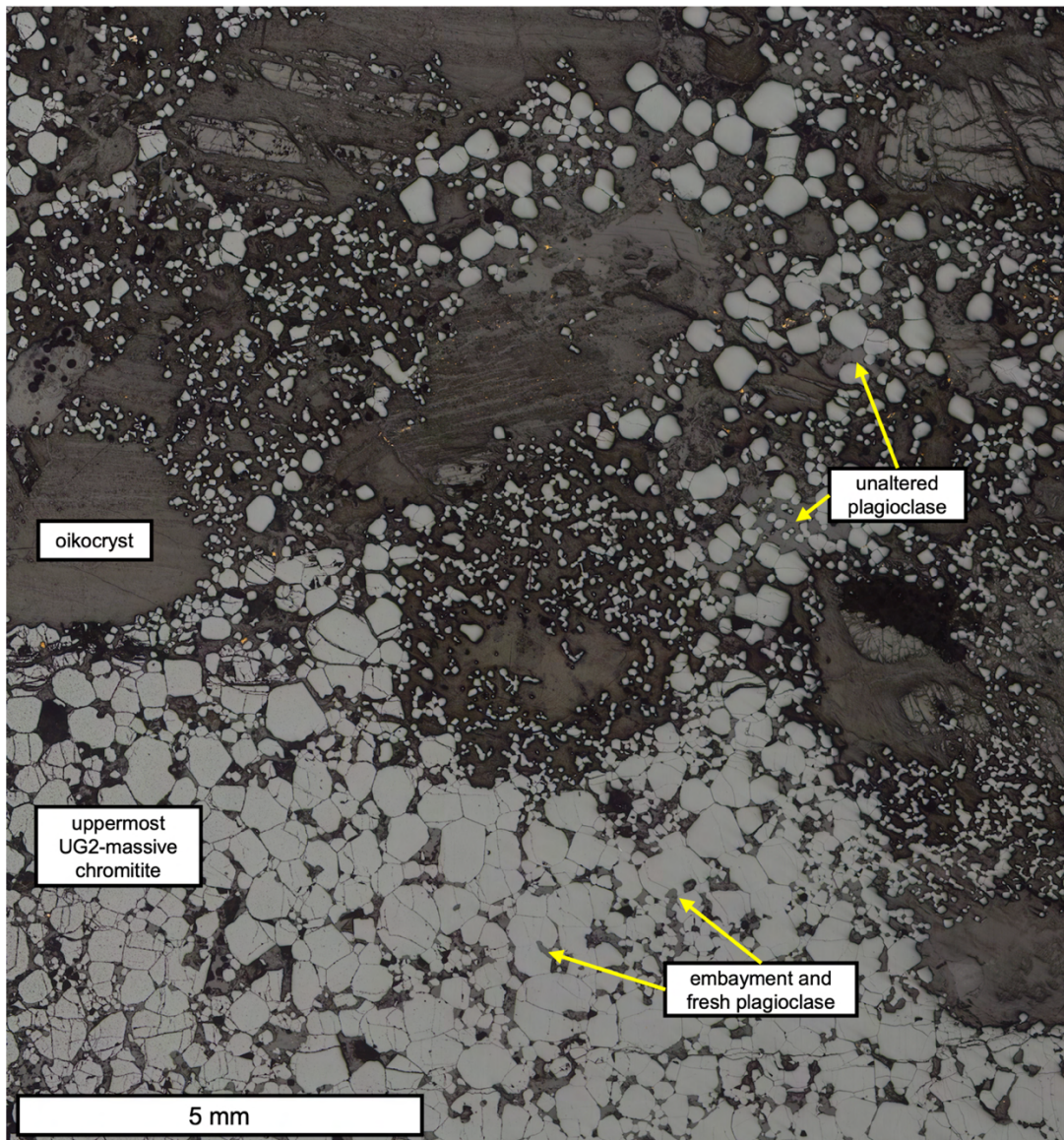


Figure 4.1.8. Photomicrographs under reflected light for the upper massive UG2 Chromitite in which there is a gradational contact to a relatively 8-cm thin layer of pyroxenite (sample 7.2), the so-called norite break. Top is to the NNE in this image.

4.2 Leader Seam Massive Chromitite

Approximately 5 cm upward from the base of the leader seam, there is an elongate cluster of pyroxene oikocrysts bearing chromite chadacrysts (Fig. 4.2.1A) aligned parallel to the base of the aforementioned chromitite. The cluster of oikocrysts is about 1-2 cm thick and bisects the massive chromitite of the leader seam (Fig. 4.2.1A). There is significant variation in chromite

grain size around these conjoined oikocrysts (Fig. 4.2.1A). For example, chadacrystic chromite grains are much smaller relative to larger massive chromite hosted in unaltered interstitial plagioclase (Fig. 4.2.1A). The chromite crystals in the leader seam chromitite are generally equant and euhedral although reprecipitation textures including etch-channels and fishhooks as described above are locally observed (Fig. 4.2.1B).

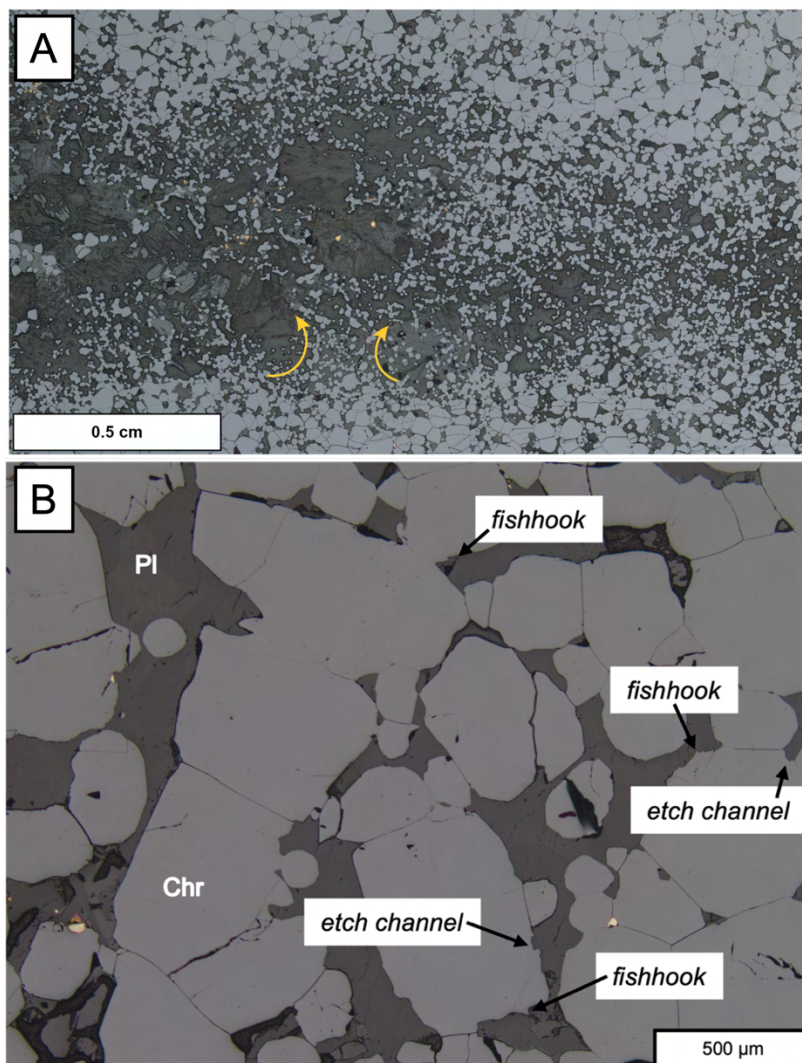


Figure 4.2.1. Photomicrographs of sample 9.2 under reflected light to show (A) oikocrysts at the center of the massive leader seam chromitite, where the yellow arrows indicate the chromite distribution around the perimeter of oikocrysts and there is a large range of chromite sizes. Top is to the N in this image. (B) Chromite (chr) dissolution-reprecipitation textures in the leader seam including etch channels and fishhook. Note that Pl represents plagioclase.

Relatively fine-grained chromite chadacrysts occur in the oikocrystic orthopyroxene (Fig. 4.2.2A). Here, the chromite grains again develop chain texture around orthopyroxene and olivine crystals similar to that developed in the footwall (Fig. 4.2.2A). Above the leader seam, chromitite and within the hanging wall, there are relatively large sulfide blebs located around orthopyroxene and chromite grains (Fig. 4.2.2B).

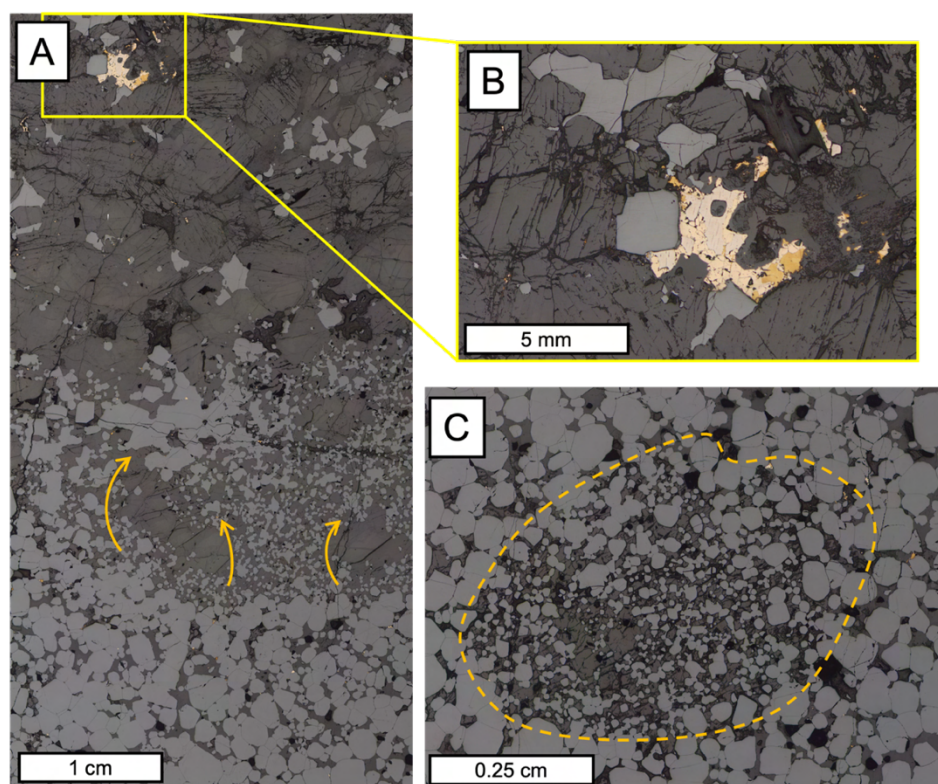


Figure 4.2.2. Photomicrographs under reflected light for sample 9.1. (A) Large and small chromite grains occur around the boundaries of orthopyroxene oikocrysts forming an ill-defined chain texture. (B) Chromite and associated sulfides fused to the grain boundaries of adjacent orthopyroxene crystals. (C) Undeformed and unaltered orthopyroxene oikocryst with poikilitic chromite grains in a host of massive coarse-grained chromitite.

Above the leader seam, the hanging wall is a feldspathic olivine websterite, with ~20 mod.% plagioclase, 40 mod.% orthopyroxene, 30 mod.% olivine, 5 mod.% chromite and 5 mod.% magnetite. The magnetite, which forms skeletal intergrowths, occurs only in ~0.25 mm thick discontinuous shear bands that cut through olivine crystals (Fig. 4.2.3C). It is important to note that there does not appear to be any continuation of this shearing elsewhere in the core sample, i.e., in the leader seam below. Chromite grains cluster to form layers sub-parallel to a foliation defined in orthopyroxene grains (Fig. 3.2.1A). Orthopyroxene grain sizes range from 1-2 cm in diameter and the crystals are euhedral, with no other alteration besides that observed in the shear zones (Fig. 4.2.3). Where the shear bands affect the orthopyroxene, there is evidence of serpentinization. There is minor sulfide (<5 mod.%) present in the alteration zones with trace sulfides also hosted in interstitial plagioclase adjacent to chromite. Additionally, large Cu-sulfides occupy the spaces between adjacent olivine and orthopyroxene grains.

The upper massive and leader seam chromitites show both faceted and rounded chromite-chromite-plagioclase apparent dihedral angle surfaces at their triple junctions (Fig. 4.2.4). The extent of the widening of the apparent dihedral angles seems to be less extreme than seen in the lower massive chromitite.

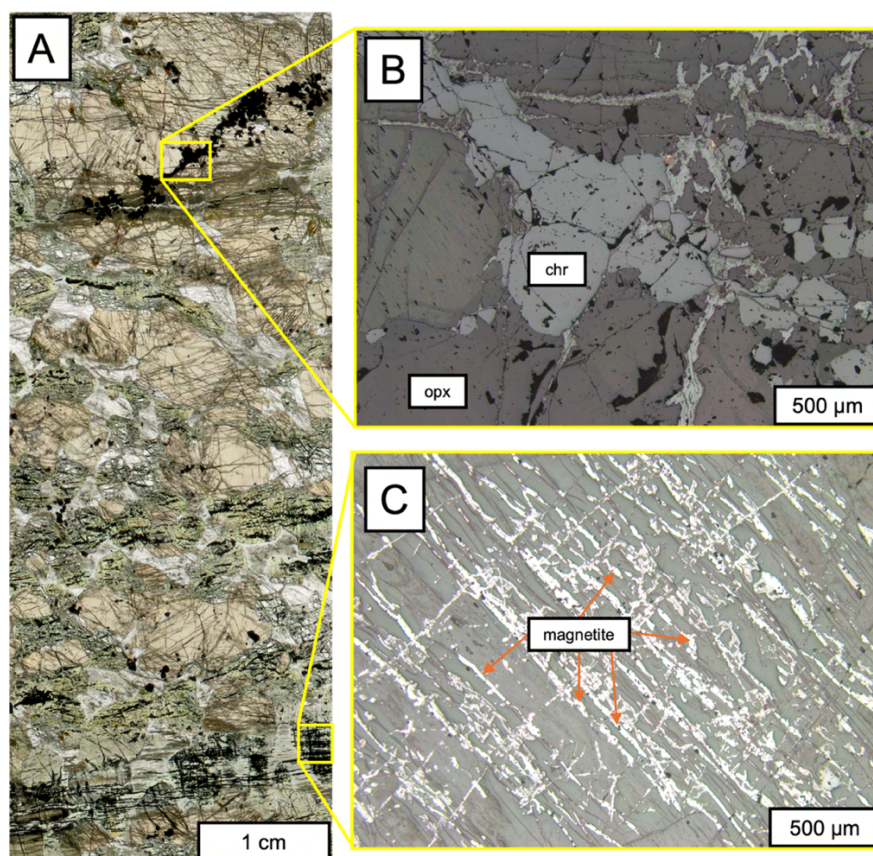


Figure 4.2.3. (A) Transmitted light photomicrograph of hanging wall norite (sample 10.3). (B) Band of anhedral chromite grains at a conjugate angle to the sub-horizontal layering of norite, taken using reflected light. (C) Exsolution lamellae of magnetite in a sheared layer in altered olivine grains, in reflected light. Abbreviations: Chr, chromite; opx, orthopyroxene.

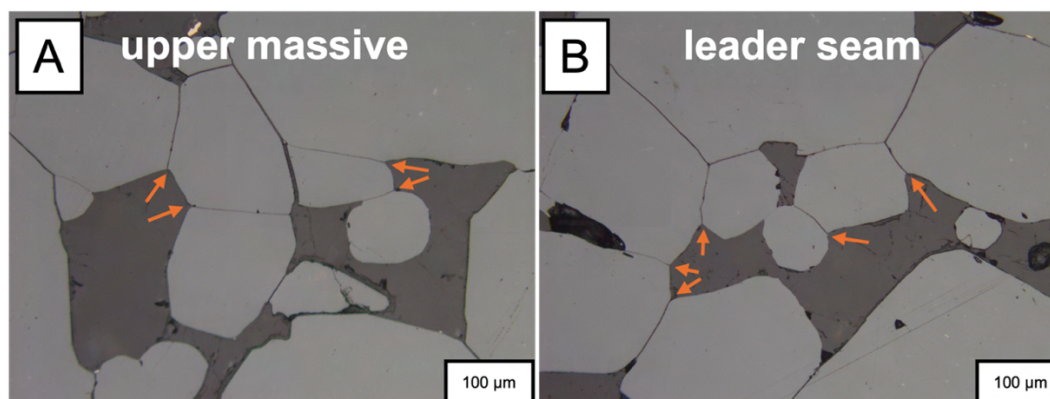


Figure 4.2.4. Apparent dihedral angle junctions (orange arrow) between chromite-chromite-plagioclase for the (A) upper massive (sample 7.1), and (B) leader seam (sample 9.3) using reflected light.

5. Analytical techniques

5.1 Crystal Size Distribution

Crystal Size Distribution (CSD) analysis provides quantitative insights into the kinetics of crystallisation and postcumulus textural modification in magmatic systems (Marsh 1988; Marsh 1998; Higgins 2000; Higgins 2006; Magee et al. 2010). This is significant because postcumulus processes may extensively alter primary textures in layered intrusions (Magee et al. 2010). CSD plots are created by plotting the logarithmic number of crystals per unit volume (mm-scale), i.e., the crystal population density versus the crystal size. The CSD is calculated volumetrically in ordered size bins. The output data yields information on the nucleation and growth rate history of crystals as well as possibly identifying time frameworks over which nucleation and crystallisation could have occurred. Applying a basic weighted linear equation ($y = mx + b$) to the output CSD curve provides insight to the parameters governing crystal nucleation and growth, where the slope, ' m ' can be expressed via the characteristic length (C_i) as ($C_i = \frac{-1}{m}$), and the y-intercept, ' b ' represents the nucleation density.

CSDs have two end-member models in igneous rocks: steady state and batch crystallisation (Marsh 1988; Marsh 1998; Magee et al. 2010). Steady state models involve continuous crystal growth in an open magma chamber system and simultaneous input/output via physical circulation (e.g., magma chamber convection; Fig 5.1.1; Magee et al. 2010). In contrast to this, batch crystallisation models involve perfectly closed magma chamber system with no crystal input/output (Fig 5.1.1; Magee et al. 2010). Either of these endmembers may produce a perfect log linear CSD plot and any deviation from such is generally interpreted as a consequence of various possible processes, including magma-mixing, mingling of multiple crystal populations, textural coarsening and compaction (Magee et al. 2010).

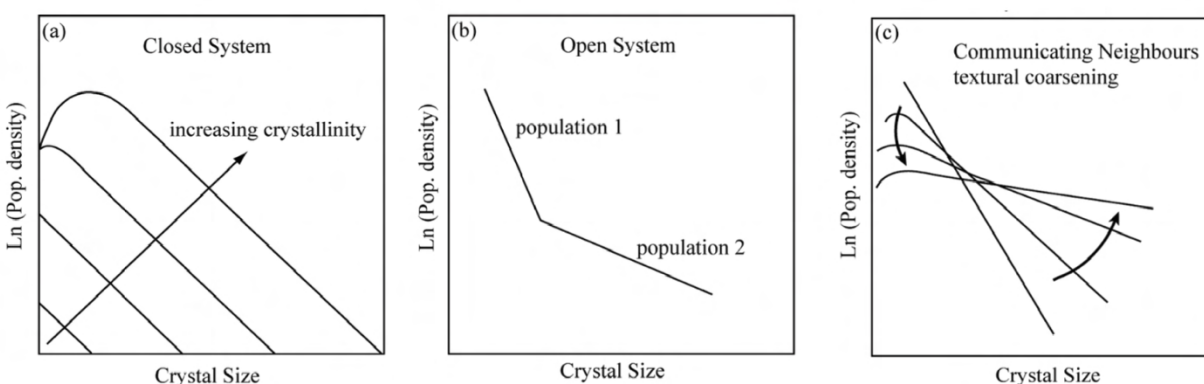


Figure 5.1.1 Theoretical scheme for interpreting CSD plots (taken from Magee et al. 2010).

Closure limits restrict the calculated crystal content to $<100\%$ and have been calculated for verification of the overall CSD quality (Marsh 1988; Marsh 1998; Magee et al. 2010). To graphically represent the closure limits for a CSD, the characteristic length (C_i) versus intercept (b) and the characteristic length versus volumetric phase abundance (V_d) are plotted for interpretation.

In this study, chromite crystals at cm-scale intervals across the footwall, massive UG2, leader seam and hanging wall in the MZK130-D2 core were subjected to CSD analysis to examine evidence for textural heterogeneity through the UG2 package. Prior to CSD analysis, a series of photomicrographs were captured through the core using reflected light microscopy on polished thin sections. These photomicrographs were stitched together using the application, ‘*panorama stitcher*’, to develop detailed maps of entire thin sections on which the outlines of individual chromite grains were then manually traced. The stitched images were carefully examined to ensure no discrepancies were present at image boundaries (e.g., continuity of grain boundaries). At least 200 chromite crystals were measured for each sample, as Mock et al. (2003) proposed this is the lower threshold for producing an accurate CSD. Using the Java-based image processing program, ‘ImageJ’, an appropriate length-scale was then calibrated for each sample. Input parameters such as crystal roundness, volumetric phase abundance (%), major, and minor axis crystal lengths were set in the CSD Corrections 1.61 software (see <https://www.uqac.ca/mhiggins/>) using ‘major ellipse axis’ as the size parameter for analysis. The program utilises a 2D image analysis and 2D-3D stereological conversion method developed by Higgins (2000) for the output CSD plot. More specifically, variables like the volumetric phase abundance (V_d) of chromite grains and the porosity of interstitial plagioclase (ϕ) are converted from the 2D thin section image into a 3D representation.

Further descriptive analysis on the CSD results were performed in Microsoft Excel using functions such as the weighted linear regression intercept, the weighted linear regression slope etc. The shape factor (σ) was calculated using the following equation (note: Ω represents roundness and is a subjective parameter used in CSDCorrections. ISL is the ratio between the intermediate, short and long axes of the grain; in this case, chromite is cubic so, the ratio used is 1:1:1):

$$\sigma = \left(1 - \Omega \left(1 - \frac{\pi}{6}\right)\right) IS/L^2 \quad [1]$$

Using a volumetric phase abundance (V_i) of 100%, the characteristic length (C_i) used to represent a plot for closure limits for chromite crystallisation was performed using the following equation, in which η represents the sample’s linear regression:

$$V_i = 6\sigma n'_{vi}(0)C_i^4 \quad [2]$$

5.2 Apparent Dihedral Angle Measurements

The apparent dihedral angle is a microstructural parameter that is useful in understanding the topology, interconnectivity and amount of a liquid phase during textural equilibrium processes in cumulate rocks (Holness 2010). Although complete textural equilibrium is rarely achieved in geologic materials more generally, particularly in the crust (Holness 2010), layered intrusion cumulates can show wide variations in their degree of textural equilibration (Holness et al. 2007; Holness 2010; Holness et al. 2012). The dihedral angle is the angle subtended between two grains at a three-grain triple junction, or the angle between the liquid-liquid-solid at the corner of a fluid-filled pore (Holness 2010). Dihedral angles are relatively straightforward to

quantify and are highly sensitive to physical conditions such as temperature fluctuations (Holness 2010). The dihedral angle is of importance in determining the equilibration distribution of a liquid phase (Holness 2010). A uniform dihedral angle represents the requirement of minimal surface energy (Veksler et al. 2018).

Preferential nucleation occurs at a grain interface along a face that is relatively immobile and maintains coherent boundaries to substrate grains versus solid matrix (Holness et al. 2023). In the samples studied here, apparent dihedral angle between chromite-chromite-plagioclase phases were measured to unravel mechanisms for which chromite may have formed in relation to its interstitial melt, which is now mainly pseudomorphed by plagioclase. In this case, measuring the apparent dihedral angle (θ) between a chromite-chromite-plagioclase junction in 2D using high resolution textural maps can provide information on the true 3D interface angle. The 3D interface angle is interpreted as the average median value for 2D chromite-chromite-plagioclase apparent dihedral angle measurements (Holness et al. 2023).

Chromite is opaque and so, instead of using the Universal Stage, we took the textural maps that formed the basis for the CSD measurements to also measure the apparent dihedral angles between chromite-chromite-plagioclase and chromite-chromite-chromite in 2D, following Holness et al. (2023). The apparent dihedral angles were measured for the groups using ImageJ with an average accuracy of 1° . A target of ~ 300 measurements per sample was set to allow for variable n . Sample 1.6C did not have enough chromite-chromite-plagioclase phase triple junctions to reach this threshold so the number of measurements for this sample is lower. Chromite-chromite-chromite dihedral angles were also measured for selected samples. Using the *Descriptive Statistics* analysis Toolpak in Microsoft Excel, the median and standard error, as well as other variables were then calculated for all samples.

Normality of the dihedral angle population can be expressed and quantified by kurtosis and skewness (Fig 5.2.1). Kurtosis describes the degree to which the frequency of a population is positively or negatively related to the mesokurtic or normal, ideal median value. Kurtosis measures the "tailedness" or sharpness of the peak of a distribution. A distribution with high kurtosis has a sharper peak and heavier tails, while a distribution with low kurtosis has a flatter peak and lighter tails. The formula for kurtosis (κ) is (X_i is each datapoint, $\bar{X}$ is the sample median, s is the standard deviation, and n is number of points):

$$\kappa = \frac{1}{n} \sum_{i=1}^n \left(\frac{X_i - \bar{X}}{s} \right)^4 - 3 \quad [3]$$

Skewness measures the asymmetry of a distribution. A distribution is considered symmetric if the left and right sides are mirror images of each other. Positive skewness indicates a distribution with a longer right tail, while negative skewness indicates a distribution with a longer left tail. The formula for skewness (γ) is (X_i is each datapoint, $\bar{X}$ is the sample median, s is the standard deviation, and n is number of points):

$$\gamma = \frac{1}{n} \sum_{i=1}^n \left(\frac{X_i - \bar{X}}{s} \right)^3 \quad [4]$$

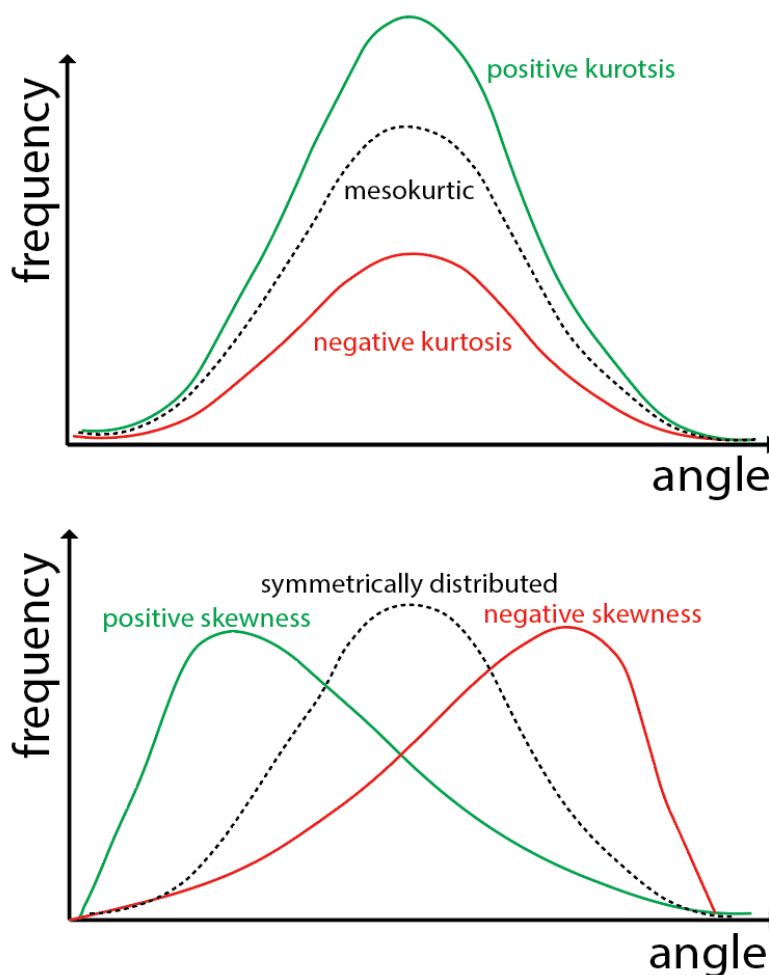


Figure 5.2.1 Parameters that quantify a population differs from its normal, kurtosis and skewness.

Harker & Parker (1945) developed the following function to determine an ideal frequency curve for any true median dihedral angle:

$$\tan \psi = \frac{2 \sin \chi \cos \theta}{\sin^2 \theta (\cos 2\phi - \cos \chi) + 2 \cos \chi} \quad [5]$$

The parameters represented in this function are as follows: ψ represents the observed angle and χ represents the true dihedral angle. Variables θ and ϕ represent the solid polar coordinates whereby $0 \leq \theta < 90^\circ$ at 10° intervals and $0 \leq \phi < 180^\circ$ at 5° intervals. This function has been applied to determine cumulative frequency distributions for dihedral angle datasets (Riegger & Van Vlack 1960; Elliott et al. 1997). In our case, we calculated median values for our measured apparent dihedral angle datasets for each sample, and then calculated a true sample dihedral angle using the equation above for that median to compare with. This allowed us to evaluate how texturally equilibrated or unequilibrated the sample might be, following Elliot et al. (1997).

5.3 Electron microprobe element mapping and point analyses

To investigate the elemental compositions of silicates and chromite in the UG2 section studied, eight thin sections representing the footwall, lower massive, upper massive, leader seam, and hanging wall of the UG2 were targeted for electron probe microanalysis (EPMA). The analyses focused on multiple areas within each section to obtain detailed elemental compositions of plagioclase, orthopyroxene, and clinopyroxene, as well as chromite.

Backscattered electron (BSE) imaging and chemical analyses of the specified minerals were performed using a JEOL-JXA 8230 Electron microprobe at the Department of Earth and Environmental Sciences, University of Ottawa. Mineral compositions and BSE images were acquired with an acceleration voltage of 20 kV, using a 10 μm beam diameter and a 20 nA beam current. The following minerals were used as standards to calibrate the machine for corresponding minerals: sanidine (K, Al, Si), diopside (Ca, Mg), albite (Na), hematite (Fe), tephroite (Mn), rutile (Ti), celestine (Sr), chromite (Al, Fe, Mg, Cr), sanbornite (Ba), vanadium (V), pentlandite (Ni) and sphalerite (Zn).

Ferric iron (Fe^{3+}) contents of chromite were calculated assuming perfect stoichiometry using the method of Droop (1987). However, Fe^{3+} values, based on the ideal formula XY_2O_4 , should be interpreted with caution due to potential inaccuracies that may lead to erroneous interpretations of small Fe^{3+} variations.

Chromite crystals targeted for microprobe analysis display textural variability, ranging from fresh and euhedral to (less commonly) altered and anhedral or ameboid shapes. In the footwall contact zone and upper massive chromitite group samples, chromite exhibits irregular grain shapes and textures, including embayments and an apparent association with chemical zoning in plagioclase. A minor secondary alteration overprint, i.e., serpentinization, was observed in a peridotite autolith in the lower UG2 massive chromitite. Quantitative point analyses were performed for all minerals of interest in 5-10 locations per thin section where the chromite volumetric phase abundance exceeded 12% to provide insights into the compositional variations within the massive chromitite packages.

5.4 $^{86}\text{Sr}/^{87}\text{Sr}$ Isotopes

Plagioclase is primarily intercumulus in the section of drill core studied, so the aim of the Sr isotope measurements is to evaluate the evolution of the interstitial melt phase at the postcumulus stage during crystallisation of the UG2 Chromitite. Thus, only fresh plagioclase, as determined from optical microscope and backscattered electron images, was targeted for spot ablation. In other words, none of the spot ablation points showed evidence of alteration in close proximity and calculated H_2O contents (from the microprobe data) on plagioclase spots close to where ablation was carried out are all zero (see appendix table A6). The *in-situ* Sr-isotope compositions of plagioclase were determined using a Thermo Scientific Neptune Plus multi-collector mass spectrometer (MC-ICPMS) and Resonetics resolution L50 laser in the Canadian

Center for Isotopic Micro-analysis at the University of Alberta (Canada). The aim of applying *in-situ* static ablation is follows the study of Hepworth et al. (2020), who identified Sr isotope heterogeneity within individual intercumulus plagioclase crystals associated with chromite mineralisation. Static ablation was performed on three samples (1.6, 2.1 and 8) using a beam with a 130 μm diameter and intensity of 7.5 J/cm^2 . Ablation took place in a Larin technic S155 cell with an He flow rate of 650 msl/min and 1.1 L/min. RF power was 1100 W. Instrument fractionation was corrected using an exponential law and internal $^{87}\text{Sr}/^{86}\text{Sr}$ TIMS (thermal ionization mass spectrometry) ratio of 0.703634. Ablation time, washout, and background were all 60 seconds with an integration time of 1.049 seconds.

All isotopes of Sr, Rb and potential interfering species were analysed using the MC-ICPMS system described above. The isobaric interference of ^{87}Rb on ^{86}Sr was corrected with the ^{85}Rb signal and a $^{87}\text{Rb}/^{85}\text{Rb}$ ratio of 0.38571. Interferences on ^{87}Sr by Rb, Ca, and Ar dimers were corrected for. Results for the $^{87}\text{Sr}/^{86}\text{Sr}$ measurement of the in-house University of Alberta plagioclase standard, which was carried out at the beginning and end of the analytical session, are illustrated in Figure 5.4.1. Each of the $^{87}\text{Sr}/^{86}\text{Sr}$ values including their 2σ error fall overlap the expected value of 0.703643, determined by TIMS, also at the University of Alberta.

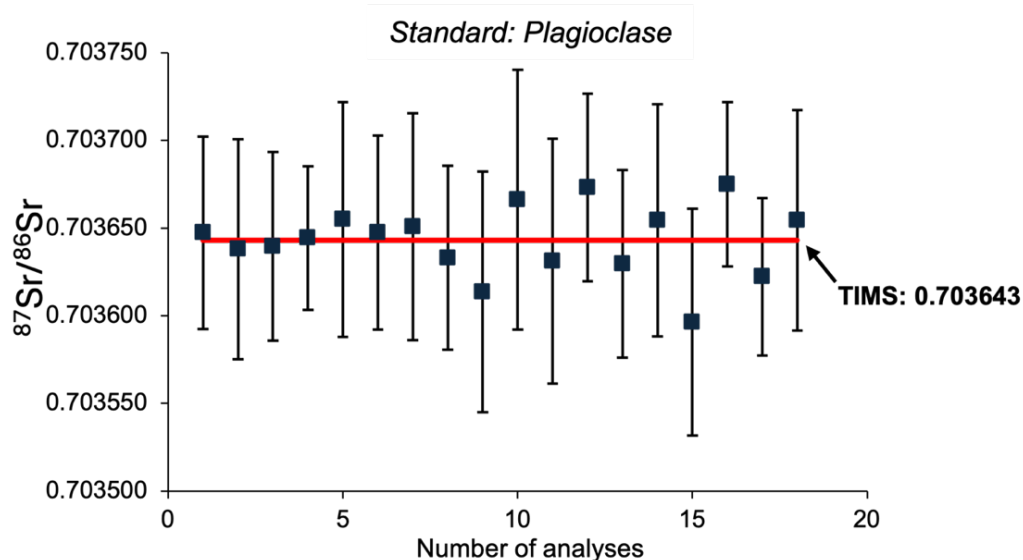


Figure 5.4.1. $^{87}\text{Sr}/^{86}\text{Sr}$ isotope results for the in-house plagioclase standard used to correct laser ablation-inductively coupled mass spectrometry measurements. The red line shows the thermal ionisation mass spectrometry-derived value for this standard.

The corrected measured isotope ratios were age-corrected to 2.055 Ga using the $^{87}\text{Rb}/^{86}\text{Sr}$ ratio and a ^{87}Rb decay constant of $1.393 \times 10^{-11} \text{ a}^{-1}$ (after Nebel et al. 2011). The initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios were calculated using the following equation where λ represents the ^{87}Rb decay constant and t represents the crystallisation age for the rock (Sambridge & Lambert 1997):

$$\left(\frac{^{87}\text{Sr}}{^{86}\text{Sr}}\right)_i = \left(\frac{^{87}\text{Sr}}{^{86}\text{Sr}}\right)_{\text{rock}} - \left(\frac{^{87}\text{Rb}}{^{86}\text{Sr}}\right)_{\text{rock}} (e^{\lambda t} - 1) \quad [6]$$

A 2σ -error was calculated for the initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio assuming an uncertainty of 1 Ma using the following equation (where η represents values for the $^{87}\text{Rb}/^{86}\text{Sr}$ ratio, λ or t , and σ_1 , σ_2 represent the uncertainties on the measured values of $^{87}\text{Sr}/^{86}\text{Sr}$, $^{87}\text{Rb}/^{86}\text{Sr}$, respectively; Sambridge & Lambert 1997):

$$\sigma_r^2 = \sigma_1^2 + (1 - e^{\eta\lambda\eta t})^2 \sigma_2^2 + (\eta_t^2 \sigma_\lambda^2 + \eta_\lambda^2 \sigma_t^2) \eta^2 e^{2\eta\lambda\eta t} \quad [7]$$

6. Results

6.1 Crystal Size Distribution

The CSD results for the MZK130-D2 core are presented in the Appendix: Table A1. Footwall, lower, middle and upper massive chromitite samples mostly show log linear profiles for which the main part of the CSDs have R^2 values ranging between 0.9-1.0. The smaller bins were not included in these regressions. The leader seam has the lowest R^2 values ranging between 0.8-1.0. All samples show a negative CSD slope and positive intercept. The steepest slope is observed in the leader sample 9.2 with a value of -35.1 mm^{-1} . The shallowest slope is -6.3 mm^{-1} in sample 1.6B of the footwall group. The intercept for all samples tends to be between $\sim 5\text{-}7 \text{ mm}^{-4}$ with the exception of sample 9.2 which reveals a greater intercept of 10.7 mm^{-4} .

Samples in the footwall tend to have a log linear size distribution apart from Sample 1.2, in which disseminated chromite grains yield a CSD with a slight downward curve at small ($\sim 0.1\text{-}0.3 \text{ mm}$) grain sizes. Chromite from Sample 1.6C, at the anorthosite-to-massive UG2 Chromitite contact, does not exceed a grain size of 0.5 mm whereas Samples 1.6A and 1.6B have the greatest grain sizes (up to 1.2 mm).

Samples in the lower massive group have log linear CSD distributions and all tend to have the maximum grain sizes of $\sim 0.8 \text{ mm}$. Sample 2.1_oik, for chromite within the orthopyroxene oikocryst only, generally contains much smaller chromite grains and reveals a maximum grain size of 0.5 mm . The two samples analysed in the interior of the massive chromitite (labelled 'middle massive' in Fig. 6.1.1) have nearly identical curves to each other with overall log linear distributions and maximum grain sizes of $\sim 0.8 \text{ mm}$. The CSD for Sample 7.2A has a log linear distribution with a maximum grain size approaching 1.2 mm . This is quite different from Sample 7.2B at the immediate upper UG2 Chromitite contact with the overlying pyroxenite. The latter CSD shows a well-developed kink at a grain size of 0.2 mm , perhaps reflecting the presence of two crystal populations.

The CSD plots for chromite samples in the leader seam are variable. Sample 9.2 does not exceed a grain size of 0.4 mm and has a log linear distribution. Samples 9.3A, 9.3B and Sample 9.4 all have a maximum grain size of $\sim 0.8 \text{ mm}$ and show a downward curved CSD with the maximum population density occurring at the $\sim 0.2 \text{ mm}$ size range. Sample 9.4B yields a complexly shaped CSD with a maximum grain size of $\sim 1.2 \text{ mm}$.

The characteristics from the CSD plots, including shape and slope, point firmly to a very heterogenous chromite population throughout the main UG2 and leader seam chromitites.

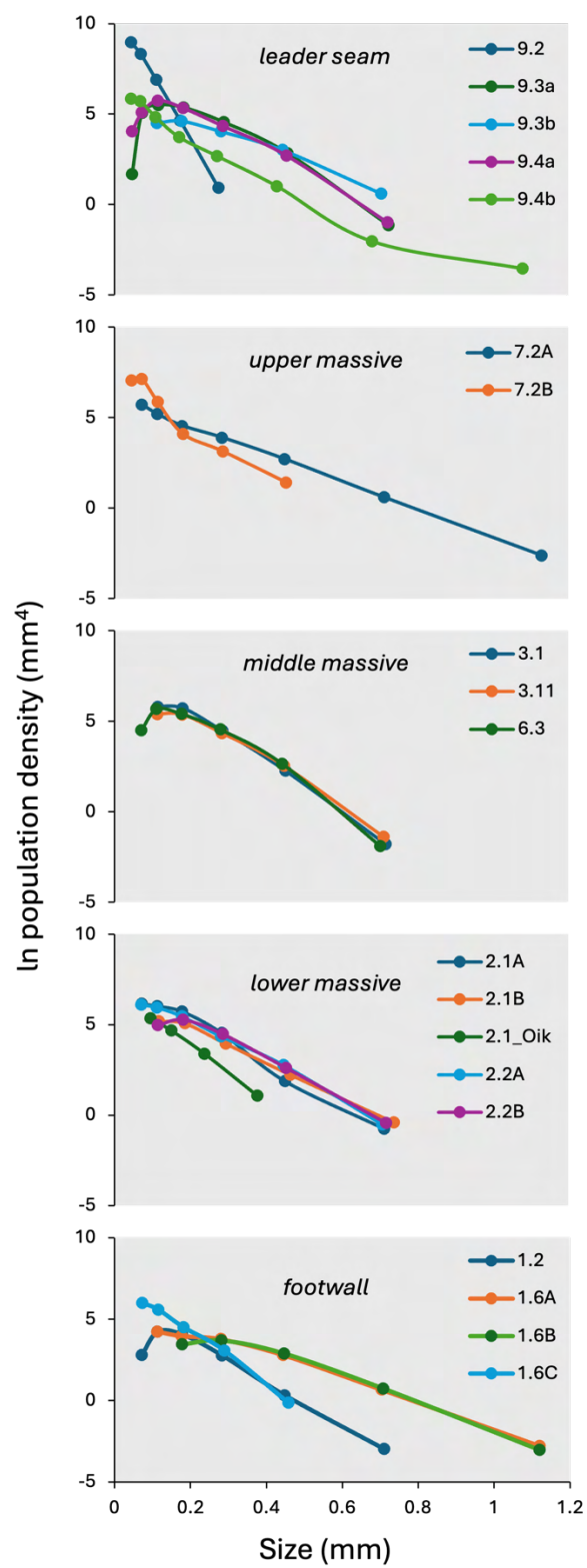


Figure 6.1.1. CSD curves for samples across the UG2, core sample MZK130-D2.

The relation between C_i and linear regression intercept is expressed in Figure 6.1.2. In the massive UG2 group there is a single cluster of points where $C_i \cong 1 \text{ mm}$ and $6.5 \gtrsim b \gtrsim 7.5$. A similar pattern is observed for clusters in the upper massive group and leader seam groups. In terms of the upper massive UG2 group there are two single points on opposing ends of each parameter's spectrum. The leader seam is significantly variable such that constituent samples do not show a regular relationship between C_i and linear regression intercept. The closure limit restricts the crystal content to $\leq 100\%$. Figure 6.1.2 also shows the closure limit for below which all sample points fall.

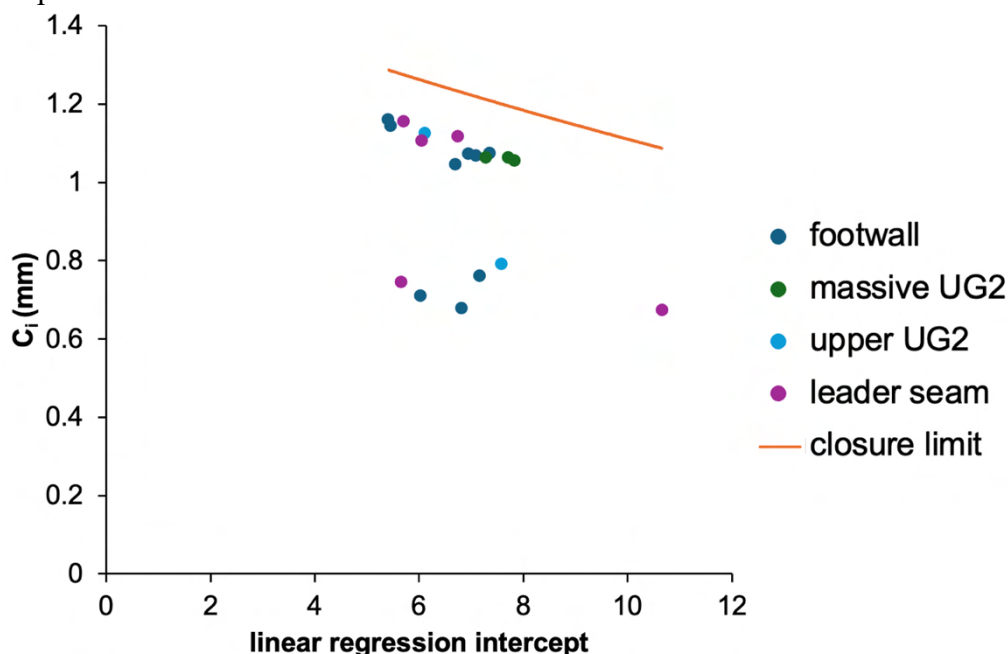


Figure 6.1.2. Plot of characteristic length (C_i) vs. the intercept for the linear regression (%) for each CSD analysis reported in Table 1. Point colours represent their relative position across the UG2 core sample (see Fig. 3.2.2).

6.2 Apparent Dihedral Angle Measurement

The Appendix (Table A2) contains the parameters produced for each sample analysis. Dihedral angle (chr-chr-plag) measurements show a heterogeneous distribution ranging over nearly 20° across the entire UG2 core sample (Fig. 6.2.1), with average apparent dihedral angles at chromite-chromite-plagioclase junctions for individual samples ranging between 62 - 85° . The greatest angle ranges within samples are found in the footwall (61 - 73°), the lower massive chromitite (67 - 72°), and the leader seam (69 - 84°). Between the footwall and lower massive groups there is a distinct stepwise change (of $\sim 10^\circ$) in the trend representing a moving average (Fig. 6.2.1). Above this, there is only a 5° increase in recorded median average apparent dihedral angle measurements, despite measurements within these groups only range by $\sim 2^\circ$ (i.e., middle massive, 73 - 75° ; upper massive 77 - 79°). There is a significant upward shift of $\sim 5^\circ$ from the upper massive to the leader seam (Fig. 6.2.1). Within the leader seam itself, there is variation, with values ranging from 69 - 85° , despite their only being a 10 cm interval for which the

measurements were taken (Fig 6.2.1). Median chromite-chromite-chromite measurements typically yield values of $\sim 120^\circ$ (see Appendix, Table A3).

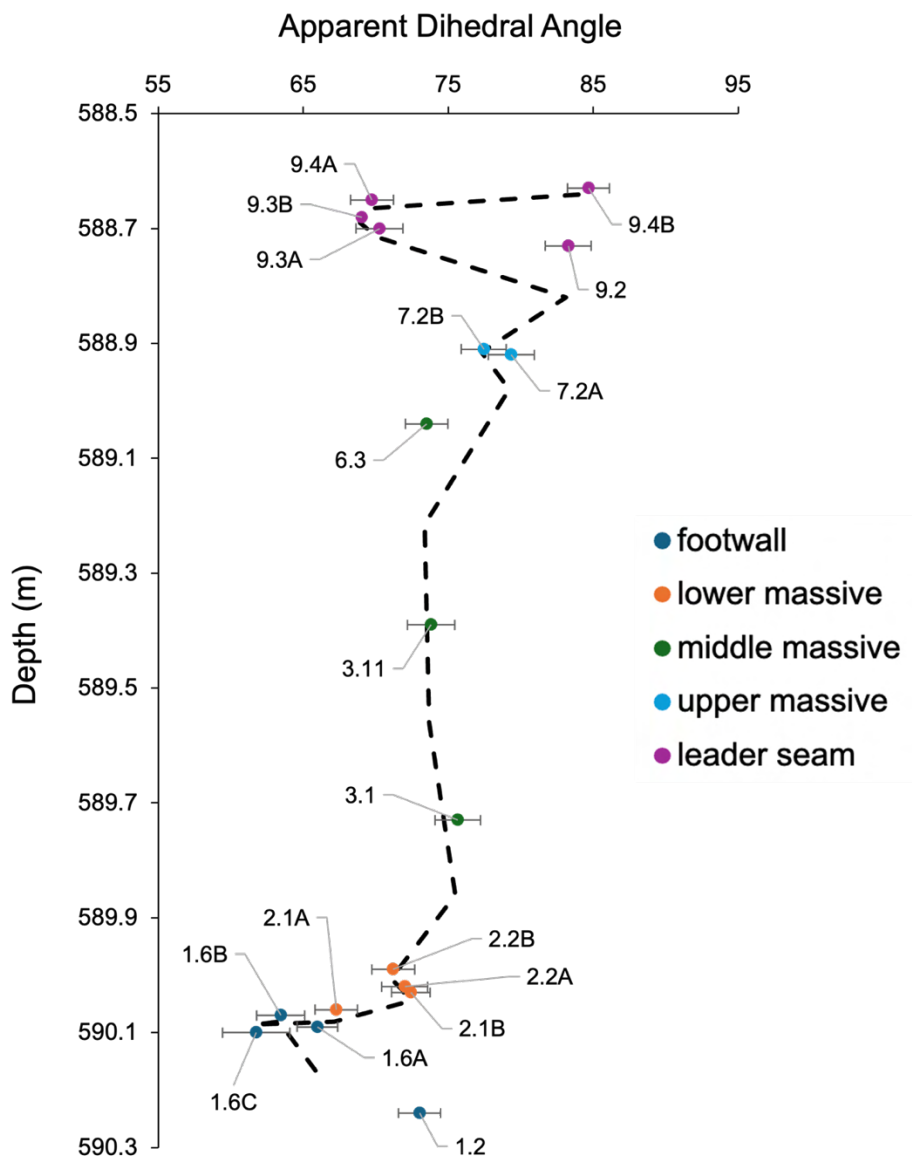


Figure 6.2.1. Median apparent dihedral angle of chromite-chromite-plagioclase for samples outlined in Figure 3.2.2. Note that the black dotted line represents the moving average for every two adjacent samples, and there is an error bar representing each sample's standard error.

6.3 Expected Normal Distribution

The Appendix (Table A4) contains the variables produced for the calculated expected true angle distributions. All sample populations deviate from a perfectly normal distribution of apparent dihedral angle measurements (Fig. 6.3.1). The kurtosis values are typically negative, though there are two outliers to this trend that show positive kurtosis (Fig. 6.3.1A). All samples show a positive skewness with only a single outlier in the lower massive group having a slightly

negative skewness (Fig. 6.3.1A). The footwall group generally has a skewness slightly less than 0.5 and a kurtosis of about -0.4 (Fig. 6.3.1A). The lower massive group has a cluster when skewness is 0.3 and kurtosis is -0.5 (Fig. 6.3.1A). There is no distinct clustering of values for the middle massive and upper massive groups (Fig. 6.3.1A). The leader seam has a dispersed range in values for kurtosis and skewness (Fig. 6.3.1A). However, there are two points making up a weak cluster which occur when skewness is nearly 0 and kurtosis is about -0.5 and the second cluster occurs when skewness is 0.5 and kurtosis is nearly 0 (Fig. 6.3.1A). The chr-chr-chr apparent dihedral angles were analysed for four samples (3.1, 3.11, 6.3 & 9.3; Fig. 6.3.1B). The latter samples show a greater kurtosis than samples measured for apparent dihedral angles (Fig. 6.3.1B). In addition, the expected distributions representing a true median value for apparent dihedral angles in each sample has been plotted in Figure 6.3.1B.

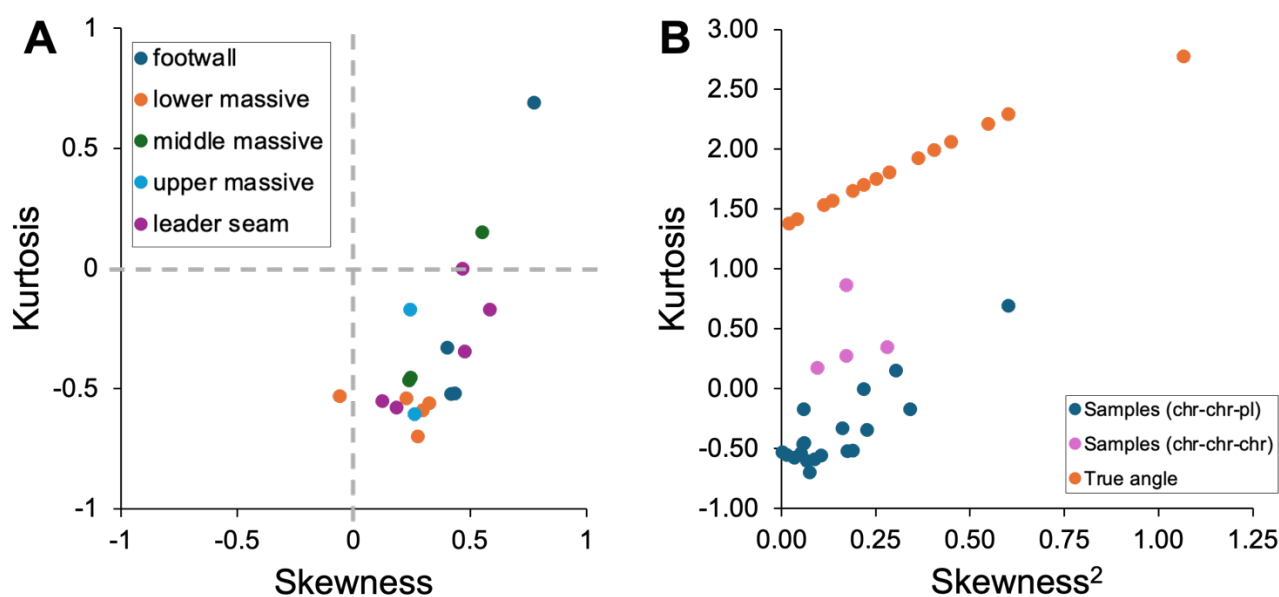


Figure 6.3.1 Normality parameters (kurtosis and skewness; Fig 5.2.1) for (A) apparent dihedral angles between chr-chr-pl across core MZK130-D2. (B) Cullen and Frey plot for apparent dihedral angles between chromite-chromite-plagioclase, triple junctions for chromite-chromite-chromite, and the expected true distribution of a given median (see Fig. 6.3.2).

The deviation from a true distribution of median apparent dihedral angles is represented in Figure 6.3.2. The expected frequency is a well-defined s-curve in which the initial slow growth phase and final plateau stage have a shallow slope in comparison to the rapid growth stage centred about the median angle (Fig 6.3.2). The cumulative frequency for each sample's median angle tends to have a much less well-defined s-curve in which the initial slow growth and final plateau stage are nearly unrecognizable because of the extensive rapid growth stage. The sample's frequency curve always shows a shallower slope relative to the steeper slope in the distribution expected for a single true value of dihedral angle (Fig. 6.3.2).

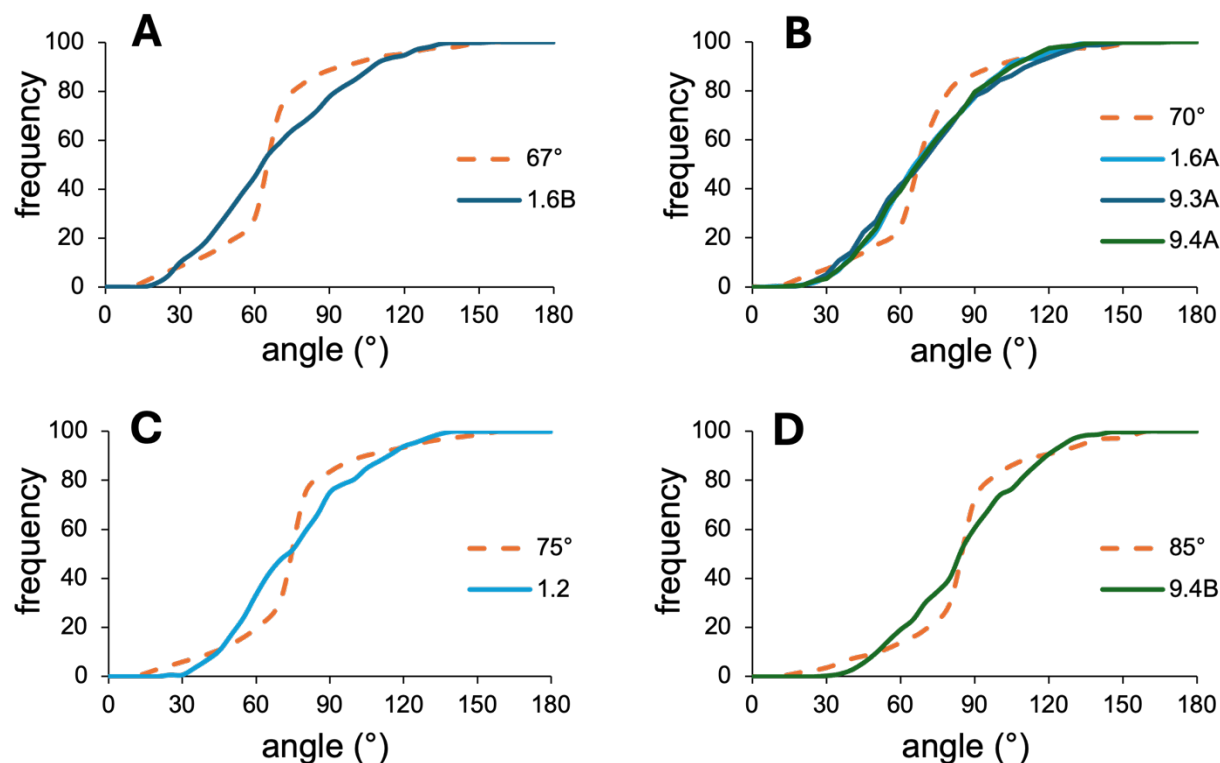


Figure 6.3.2. Cumulative frequency distribution of the observed (measured) angles (solid curve) and an expected frequency for a true distribution for a particular median angle (orange dashed curve) of apparent dihedral angle (A) 67°, (B) 70°, (C) 75° and (D) 85° for selected samples.

6.4 Electron Microprobe Element Mapping

The Appendix (Figs. A1-A6) contains all the element maps produced. The most detailed element mapping was carried out on the footwall and lower massive samples. Complex chemical zoning of plagioclase based on the distribution of Na and Ca is observed in intercumulus plagioclase (Fig. 6.4.1). Complex and patchy variations of Na in interstitial plagioclase, particularly in sample 2.1B (Fig. 6.4.1), are observed. Depletion of Na tends to occur next to chromite grains although this pattern is not ubiquitous. Conversely, Na appears most enriched when distal from chromite grains (Fig. 6.4.1). As expected, there is a weak correspondence of high Ca where Na is depleted. It is important to note that these variations are not associated with plagioclase that appears altered by low temperature (i.e., hydrous) processes in any way, optically or in backscattered electron images.

Chemical zoning of interstitial plagioclase in the upper massive UG2 and leader seam samples is also observed (Fig. 6.4.2). The zoning patterns in samples 7.2B and 9.4A are less intense and irregular compared to those observed in the footwall and lower massive samples.

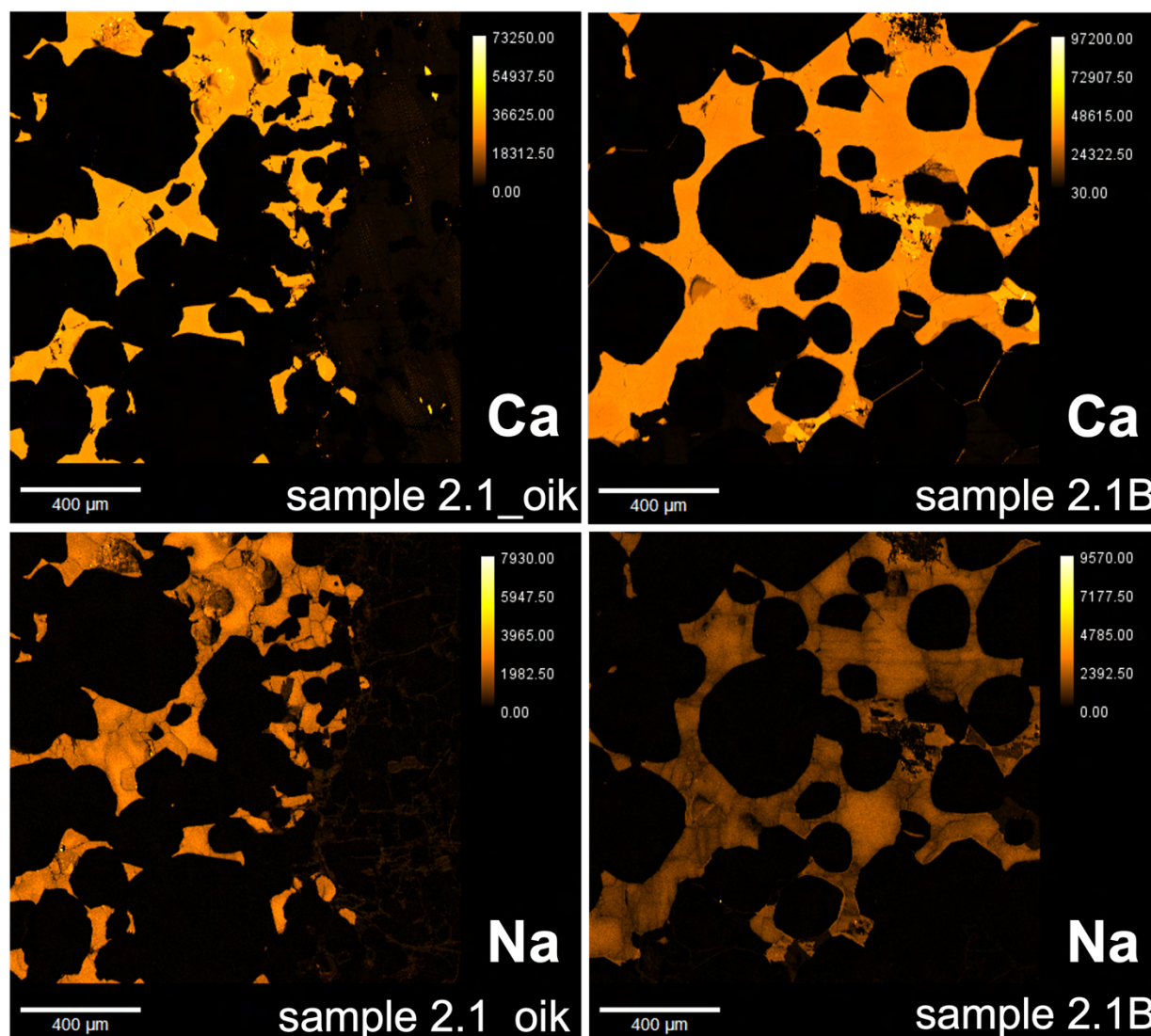


Figure 6.4.1 Element maps for footwall and lower massive samples showing element variation for Na and Ca. Note that the units for these values are raw x-ray counts.

Plagioclase reaction rims separate orthopyroxene from chromite (Fig. 6.4.3). In sample 1.6C, the Fe and Mg maps show this texture well, with interstitial plagioclase occupying the space between orthopyroxene the adjacent chromite grains (Fig. 6.4.3). The Fe and Mg variations also define well the complex boundaries of an orthopyroxene oikocryst in massive chromitite (Sample 2.1_oik, Fig 6.4.3).

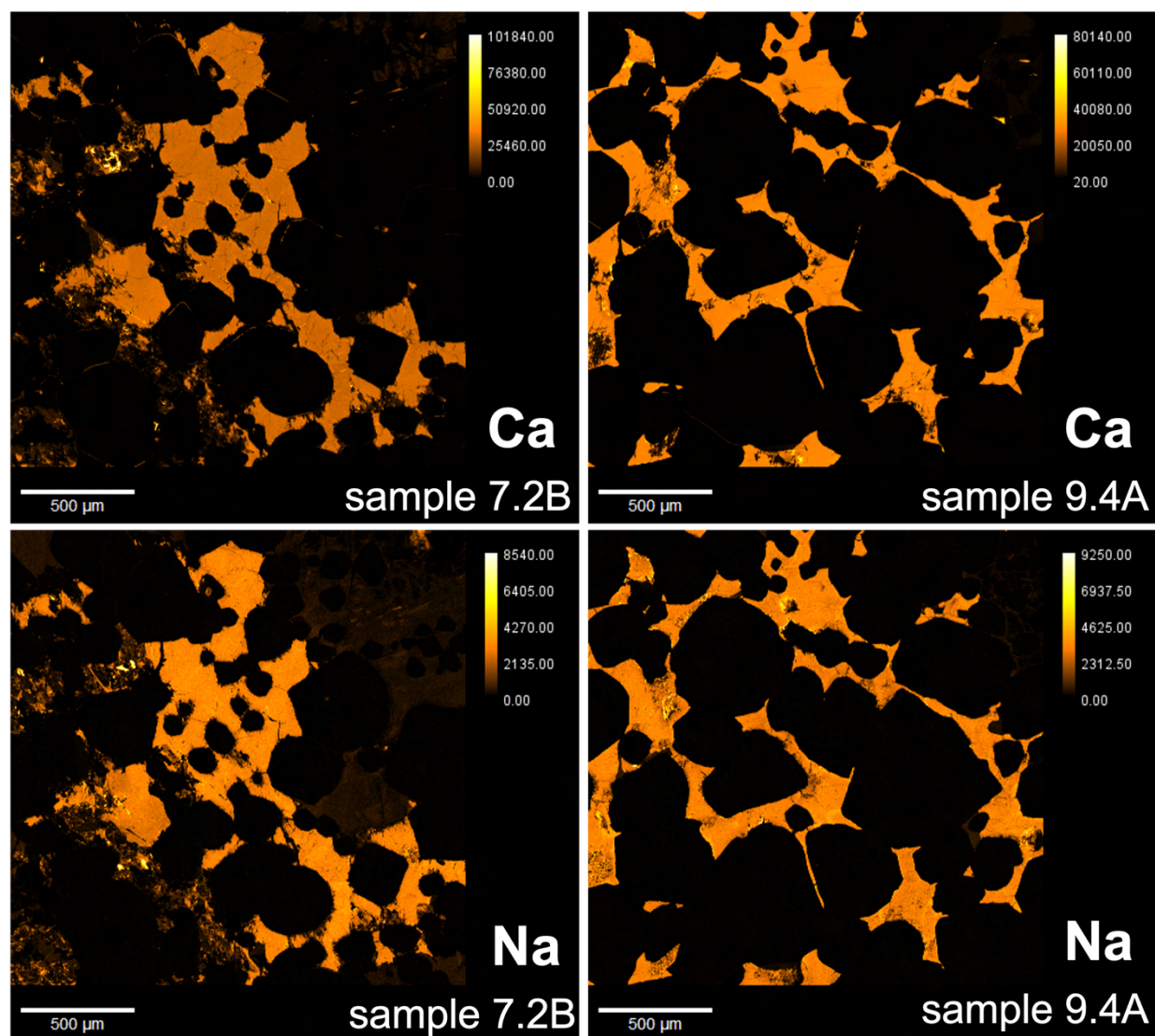


Figure 6.4.2 Element maps for upper massive UG2 and leader seam samples showing element variation for Na and Ca. Note that the units for these values are raw x-ray counts.

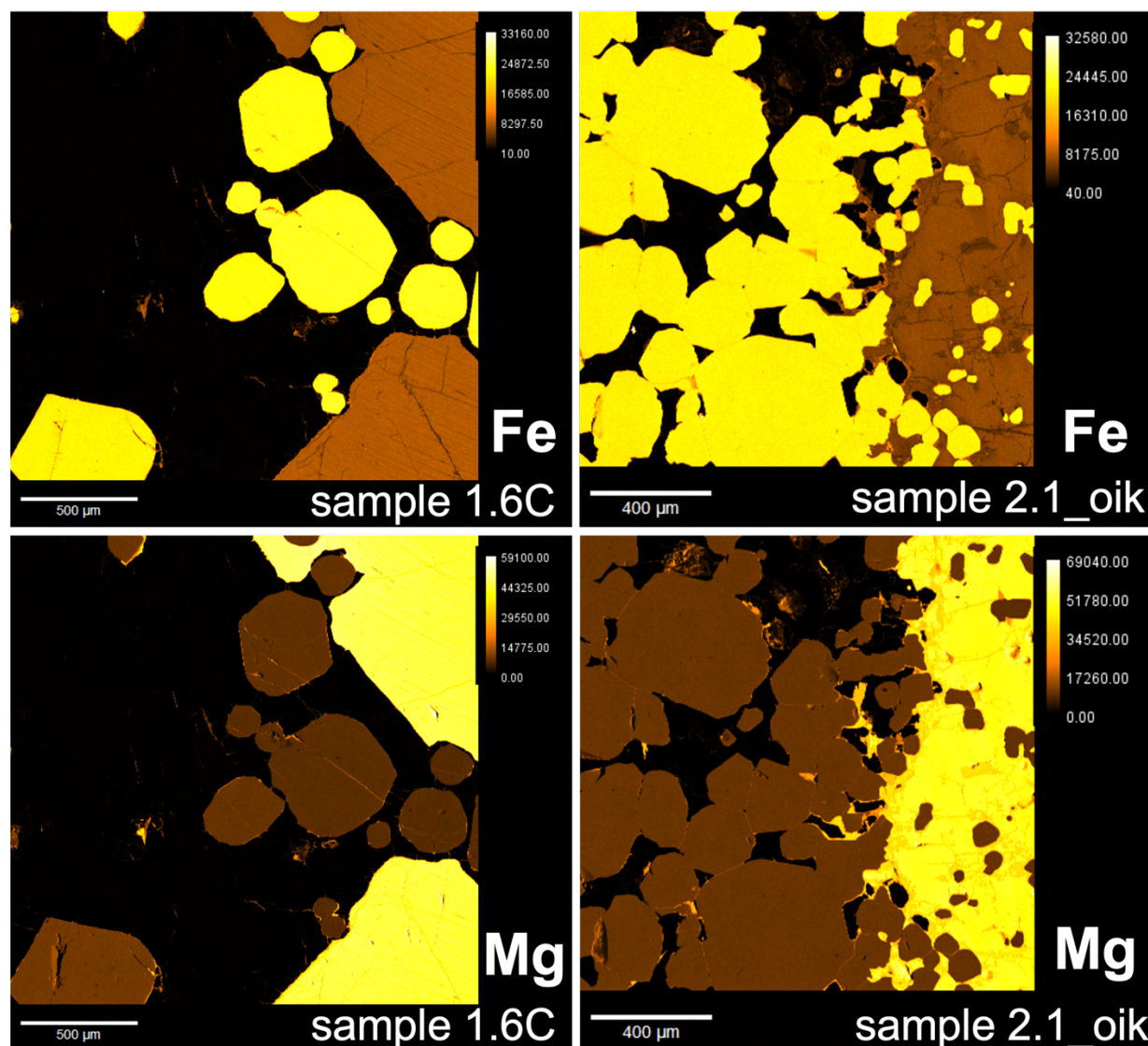


Figure 6.4.3. Element maps for footwall and lower massive samples showing element variation for Fe and Mg. Note that the units for these values are raw x-ray counts.

6.5 Mineral Chemistry

The Appendix contains raw mineral chemical data for plagioclase (Table A6), orthopyroxene (Table A7), and chromite (Table A8).

6.5.1 Plagioclase

Elemental variation in plagioclase was characterised by quantitatively measuring 277 points across the UG2 core sample. The analysis points all targeted fresh plagioclase with no evidence of alteration. The anorthite content ranges 48-100 mol.% throughout the core (Fig. 6.5.1.1). The most significant plagioclase compositional variation is found in the footwall and lower massive chromitite groups of samples. The footwall anorthite content ranges between 57-

76 mol.% and the lower massive chromitite has plagioclase with 70-91 mol.%. Sample groups at the top of the UG2 including the upper massive, leader seam and hanging wall have plagioclase with anorthite contents mainly ranging between 48-82 mol.%, though a few outliers exceed 90 mol.%. With the exception of these outliers, the upper massive chromitite group ranges 53-78 mol.%, the leader seam ranges 48-75 mol.%, and the hanging wall ranges 48-82 mol.%.

Of particular interest is also plagioclase FeO variability. Plagioclase FeO contents in the footwall and lower massive chromitite are always <0.1 wt.%. In the upper massive chromitite, FeO values range from 0.01-0.7 wt.%. The leader seam plagioclase ranges between 0.02-0.72 wt.%, and the hanging wall values range between 0.02-1.13 wt.%. The leader seam has a cluster of points at relatively high An content where FeO is slightly less than 0.8 wt.% (Fig. 6.5.1.1).

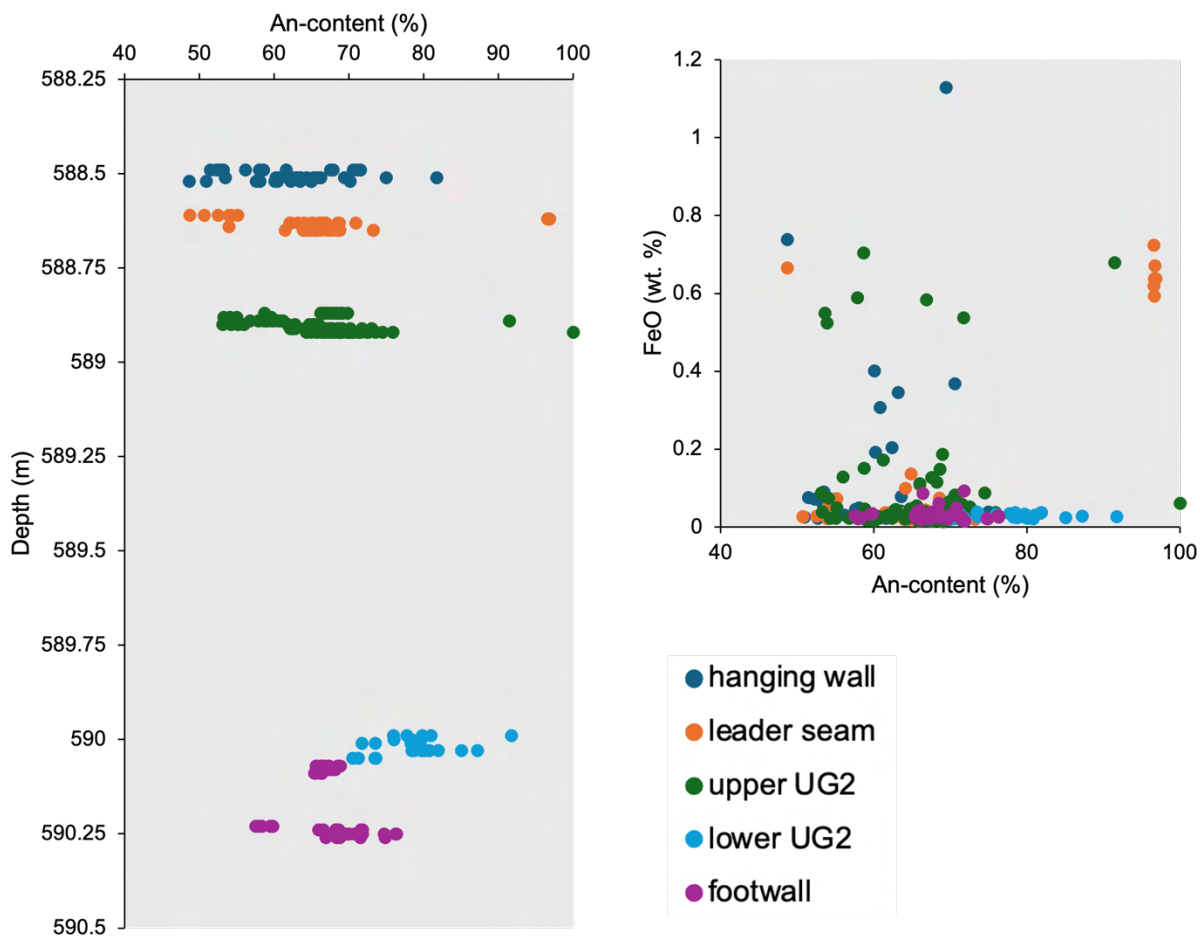


Figure 6.5.1.1. Variation of An-content in plagioclase represented as a function of depth across the UG2 core sample. The relationship between An-content (%) and FeO wt.% is represented on the right.

6.5.2 Orthopyroxene

The Al/Si contents of UG2 orthopyroxene consistently average ~ 1.03 across each of the lithological groups (Fig. 6.5.2.1). The Mg# ($Mg\# = \frac{Mg}{Mg+Fe^{2+}}$ [8]) across the UG2 averages at ~ 0.85 overall. This average increases to 0.88 for the lower massive chromitite group. The leader seam orthopyroxene Mg# averages ~ 0.86 and the hanging wall ~ 0.82 . The groups below and including the leader seam have an orthopyroxene Mg# range of ~ 0.82 - 0.91 . This range of Mg# is more restricted for orthopyroxene in the hanging wall rocks, which exhibit values between 0.81-0.85.

Regarding the relationship between Mg# and Al in orthopyroxene (Fig. 6.5.2.1), no distinct correlations are observed for any of the groups. The lithological subdivisions are reasonably well reflected in this plot; for example, the hanging wall orthopyroxene having significantly lower Mg# than the other groups.

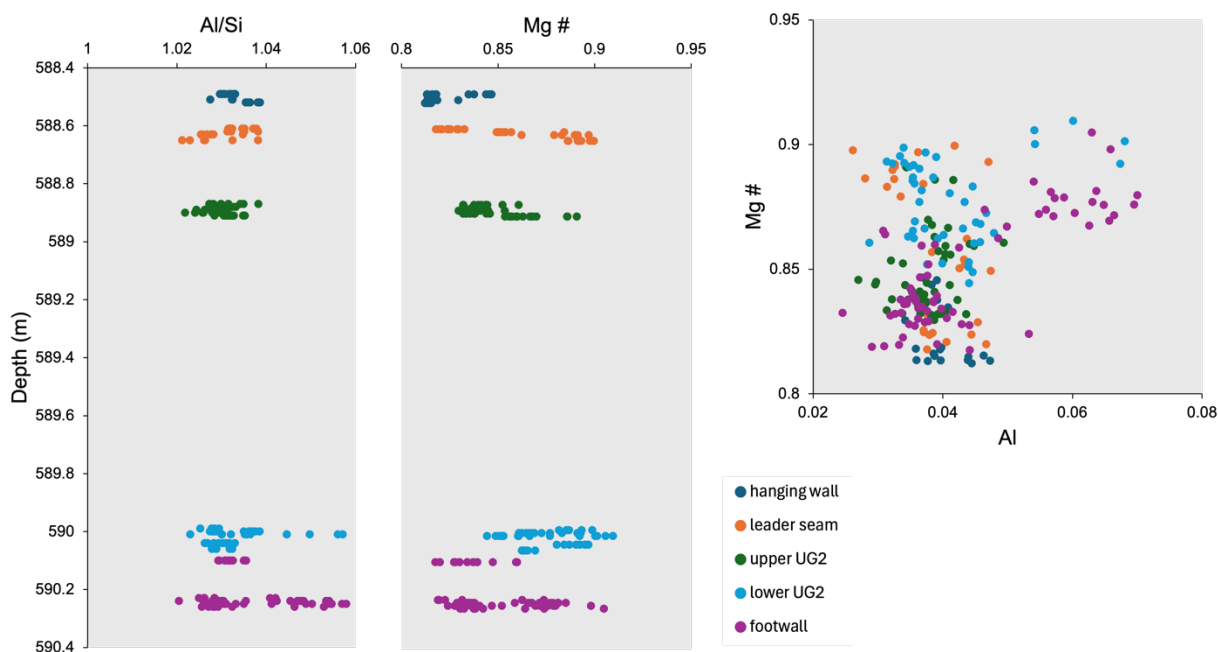


Figure 6.5.2.1. Al/Si and Mg # in orthopyroxene represented as a function of depth. A plot of Mg# versus Al (apfu) is also shown.

6.5.3 Chromite

Chromite Cr# ($Cr\# = \frac{Cr}{Cr+Al}$ [9]) values are highest in the footwall and lowest in the hanging wall (Fig. 6.5.3.1). A trend is present in which the Cr# is relatively high in the footwall and becomes slightly lower in the lower massive chromitite. Transitioning into the upper massive chromitite, pyroxene Cr# increases and then progressively decrease throughout the leader seam to reach the lowest Cr# orthopyroxene values in the hanging wall.

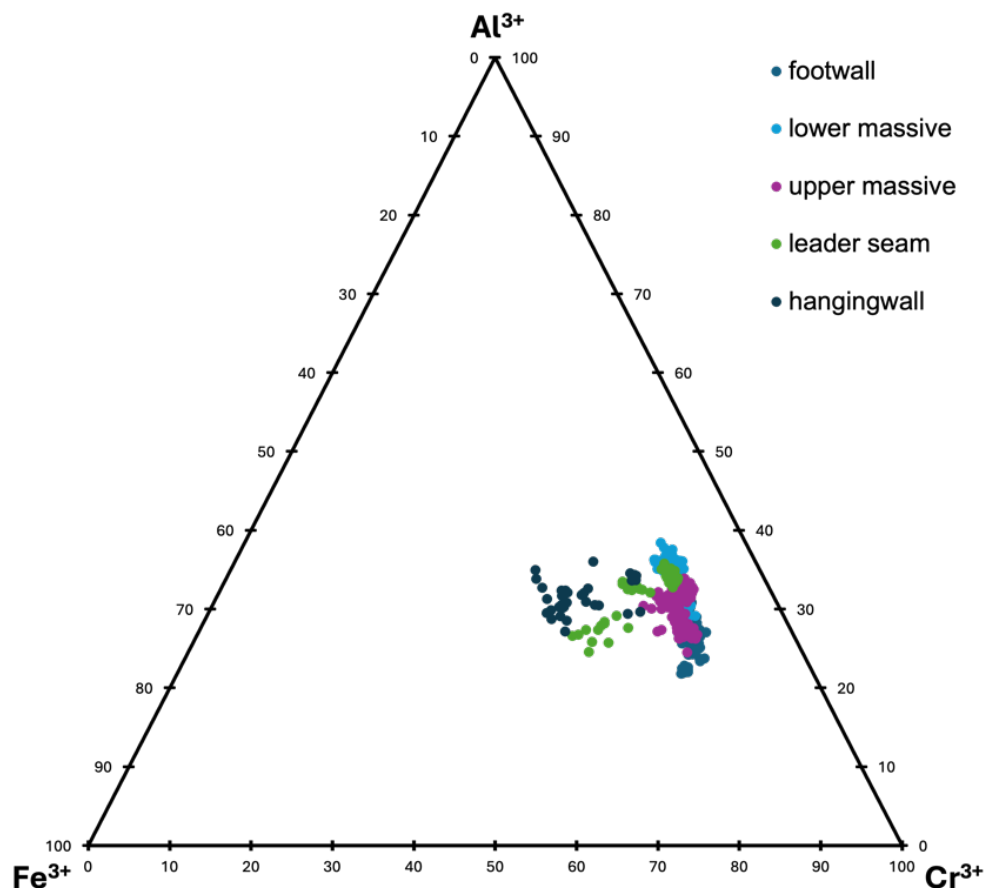


Figure 6.5.3.1. Ternary diagram for chromite grains showing the distribution of Al^{3+} , Fe^{3+} , and Cr^{3+} variability in groups across the UG2.

Chromite Mg# is variable whereby values are ~ 0.25 in the footwall and increase to >0.25 in the lower massive chromitite (Fig. 6.5.3.2). As for the upper massive chromitite, Mg# ranges between 0.14-0.42. This range broadens in the leader seam where values range between 0.07-0.41 and narrows again with minimal ranges in the hanging wall rocks between 0.11-0.29. As expected, values of Fe# ($\text{Fe\#} = \frac{\text{Fe}^{2+}}{\text{Fe}^{2+} + \text{Mg}}$ [10]) have the inverse relationship to Mg# for all groups.

Chromite TiO_2 contents do not exceed 2 wt. % in the footwall (Fig. 6.5.3.2). In the lower massive chromitite, TiO_2 does not exceed 1 wt.%. In the upper massive chromitite, TiO_2 ranges 0.18-1.23 wt.%. This trend nearly doubles in values for the leader seam and hanging wall. The leader seam values range 0.63-3.92 wt.% and for chromite in the hanging wall, 1.02-3.01 wt.%. The TiO_2 for the hanging wall chromite does not fall below the greatest value recorded for the lower massive group.

The relationship between TiO_2 and both Cr# and Mg# in chromite is also explored (Fig. 6.5.3.3). For the footwall, Cr# ranges 0.65-0.74 and decreases to 0.57-0.68 in the lower massive chromitite. The upper massive chromitite has chromite with slightly higher Cr# when TiO_2 is greater than 1 wt.%. The leader seam and hanging wall have the most variable relationship

between chromite Cr# and TiO_2 , in which Cr# is as low as ~ 0.6 and TiO_2 is relatively elevated at nearly 4 wt.%.

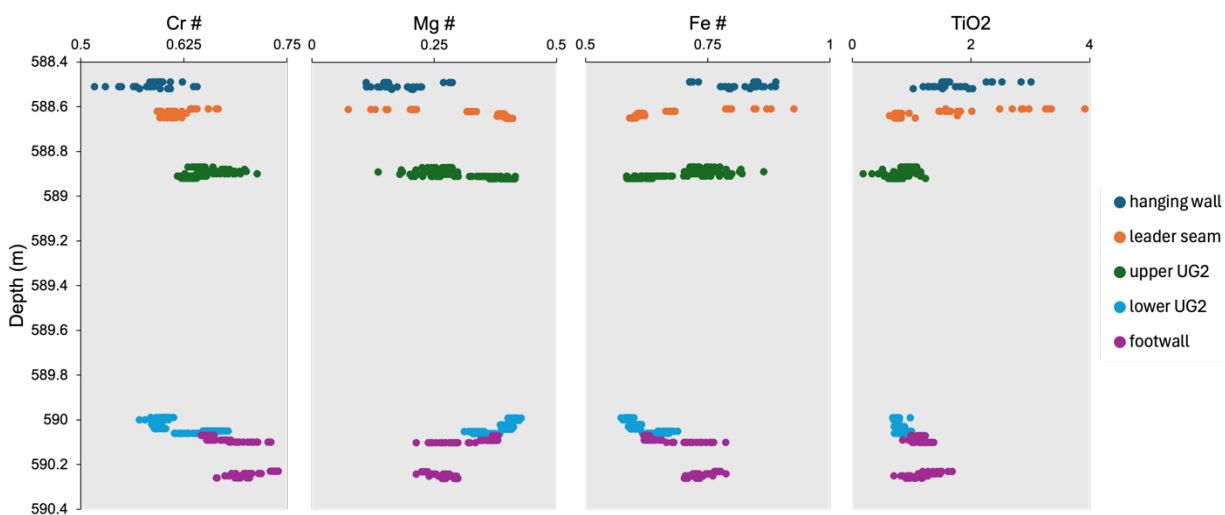


Figure 6.5.3.2. Depth plots for Cr#, Mg#, Fe# and TiO_2 (wt. %) for chromite grains in the UG2 core sample MZK130-D2.

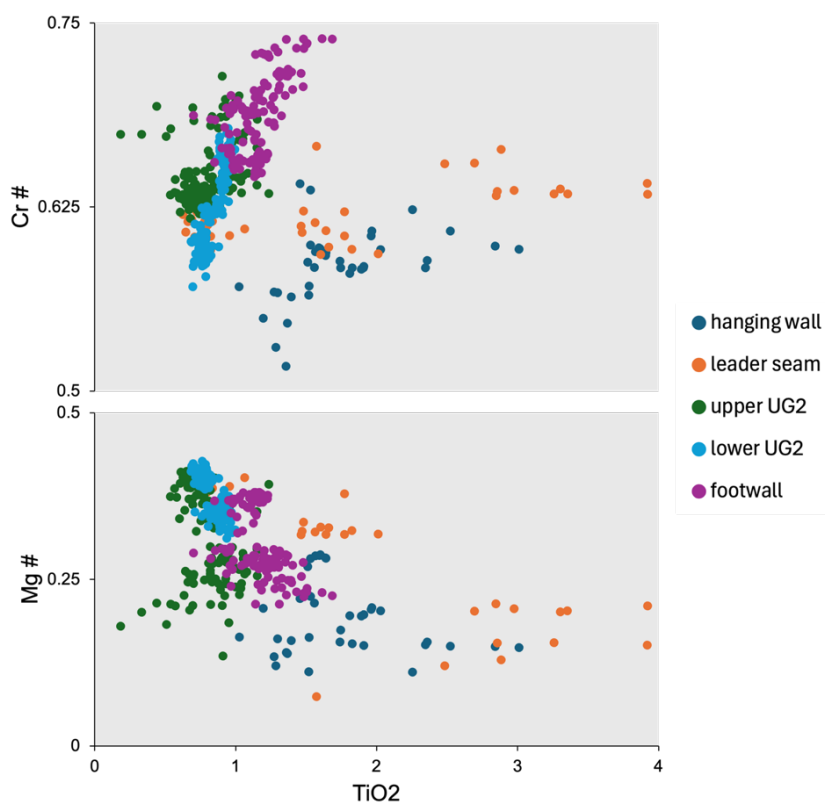


Figure 6.5.3.3. Relationship between TiO_2 versus Mg# (bottom) and Cr# (top) for chromite grains in the UG2 core sample MZK130-D2.

6.6 $^{86}\text{Sr}/^{87}\text{Sr}$ Isotopes

The Appendix (Table A5) contains the raw LA-ICPMS results. The corrected results for *in-situ* laser ablation on MZK130-D2 samples are tabulated in the Appendix (Table A6). The corrected results are filtered to show the most robust results to ensure accuracy. For example, the natural $^{84}\text{Sr}/^{86}\text{Sr}$ ratio is ~ 0.0565 so, should the $^{87}\text{Sr}/^{86}\text{Sr}$ values exceed the range of 0.0564 - 0.0567 ± 0.0001 , they are not discussed further. As well, any sample for which problems during the analytical runs were reported or for which uncertainties on the measured (corrected) $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of >0.0001 are also discarded. The Appendix tabulates all of the data collected and distinguishes between those used for discussion and those not included. Plagioclase compositions in the areas targeted for Sr isotope work were generally well characterized using the electron microprobe and show no evidence of low temperature (hydrous) alteration.

In Sample 1.6, initial $^{87}\text{Sr}/^{86}\text{Sr}$ variability in plagioclase is present with a range of 0.705942 - 0.706513 (Fig. 6.6.2).

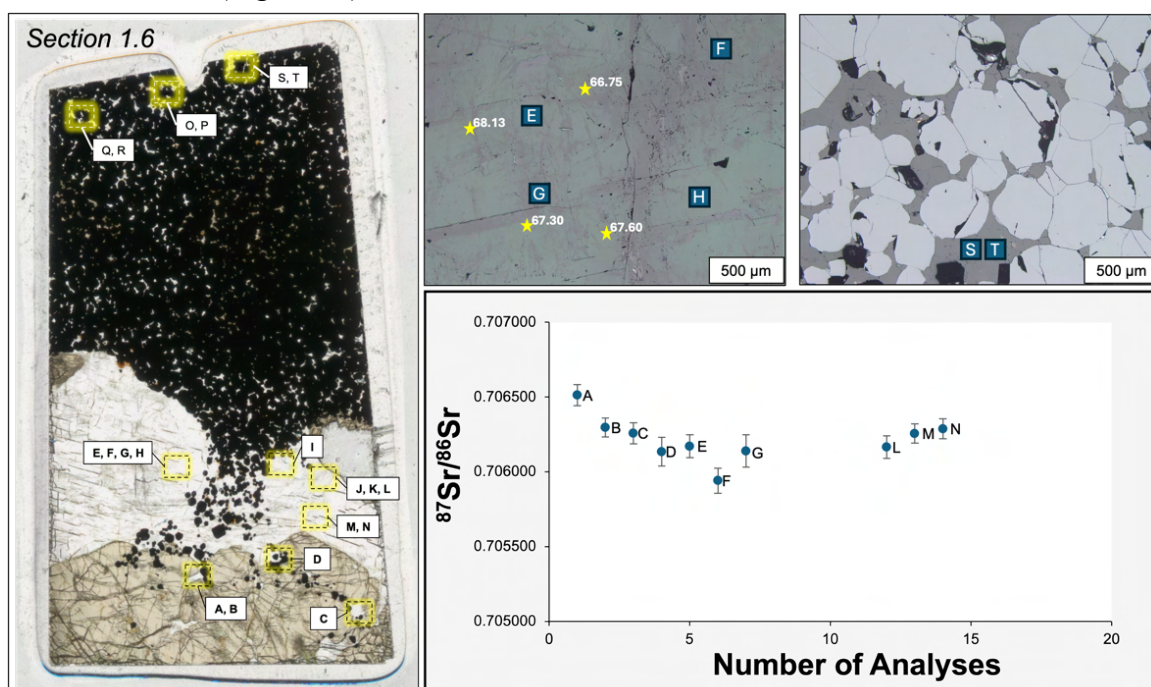


Figure 6.6.2. Left image shows the positions of the $^{87}\text{Sr}/^{86}\text{Sr}$ LA-ICPMS spot analyses (yellow highlighted box) and bottom right plots the $^{87}\text{Sr}/^{86}\text{Sr}$ initial isotope ratios for footwall Sample 1.6. Top right shows two photomicrographs displaying the positions of spots E, F, G, H (left) and nearby wt.% An-contents (yellow star) and the spots S and T (right).

The lower massive UG2 (Sample 2.1) plagioclase reveals initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios ranging 0.706463 - 0.706933 (Fig. 6.6.3). The Na-element map (shown in Fig. 6.4.1) allows the tentative correlation of relatively unradiogenic Sr isotope values with relatively low Na interstitial plagioclase at spot P (Fig. 6.6.3).

The norite break above the upper massive UG2 (Sample 8) shows plagioclase $^{87}\text{Sr}/^{86}\text{Sr}$ values ranging 0.705867-0.706534 (Fig. 6.6.4). As for the other two samples, there is resolvable initial $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic heterogeneity present.

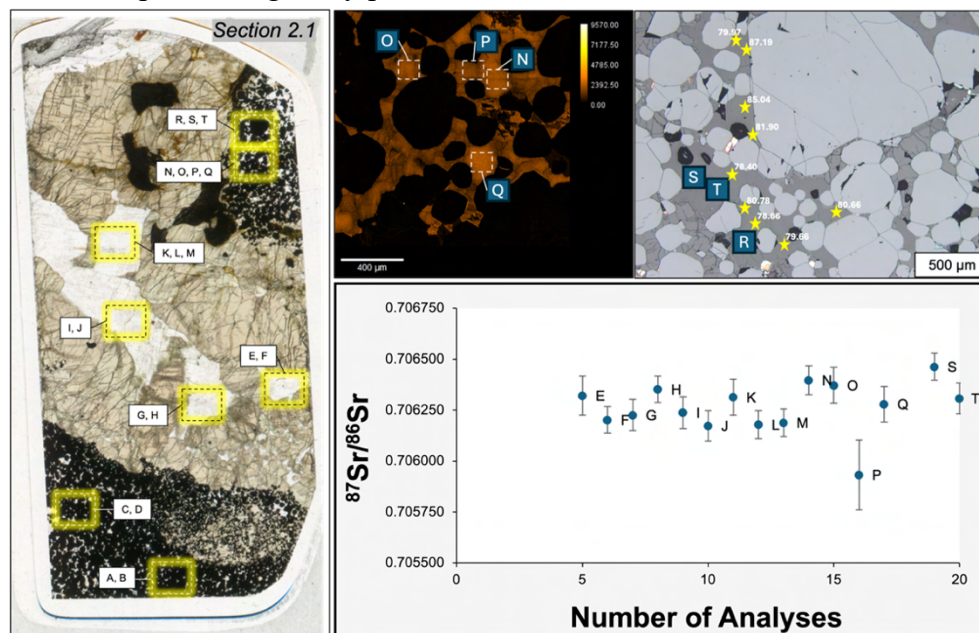


Figure 6.6.3. LA-ICPMS $^{87}\text{Sr}/^{86}\text{Sr}$ spot analysis point positions (yellow boxes in left) and initial $^{87}\text{Sr}/^{86}\text{Sr}$ results (bottom right) for lower massive UG2 chromitite sample 2.1. Top right shows a close up of spot locations (N, O, P, Q) on the Na-element map presented in Figure 6.4.1 and a photomicrograph (in reflected light) displaying spots S, T, and R with nearby wt. % An-content (yellow stars).

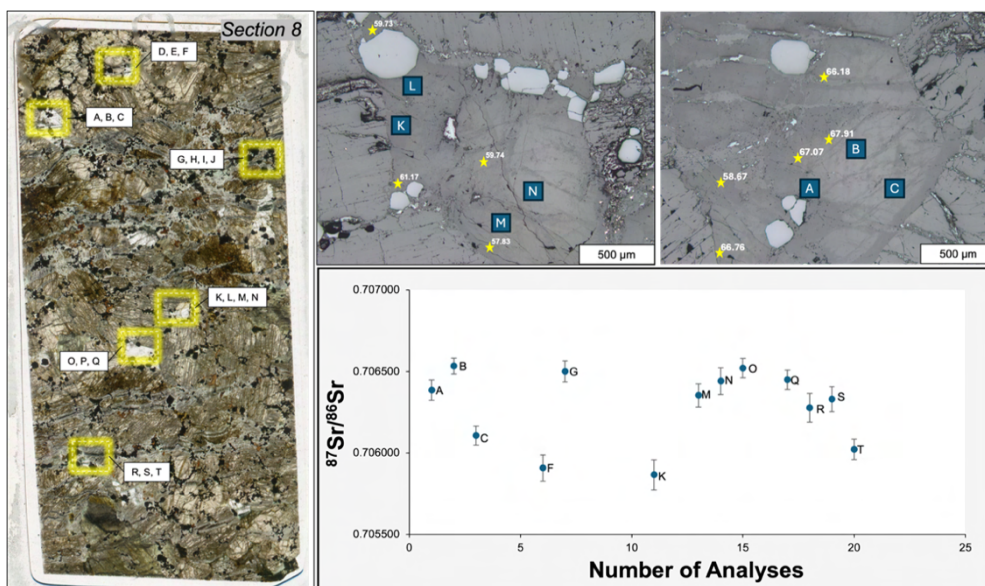


Figure 6.6.4. Initial $^{87}\text{Sr}/^{86}\text{Sr}$ spot analyses and isotope results for the norite break in Sample 8. Two photomicrographs under reflected light displaying the proximity of $^{87}\text{Sr}/^{86}\text{Sr}$ spot analyses and adjacent wt. % An-content (yellow star).

7. Discussion

7.1 Disequilibrium crystallisation across the UG2 Chromitite footwall

If gravity settling from the magma column controlled the formation of the UG2 massive chromitite, sorting of crystals perhaps including a normal size gradation pattern in which larger grains of chromite underlay smaller ones might be expected. In that light, the CSD data presented here do not support crystal settling (Fig. 6.1.1), because relatively large chromite size populations occur in the footwall, upper UG2 and leader seam, i.e., there is no consistent size grading across the chromitite. The majority of the CSD plots instead suggest that the massive UG2 Chromitite may have crystallized *in-situ*, because of their log-linear trends. Log-linear chromite CSDs have previously been interpreted to indicate *in-situ* crystallisation in the UG2 Chromitite, in other massive chromitites of the Bushveld Complex, and in chromitites from other layered intrusions (O'Driscoll et al. 2010; Veksler et al. 2018; Kaufmann et al. 2018; Hepworth et al. 2020). The CSDs also reveal evidence of the influence of textural annealing on chromite crystallisation, particularly where there is a downward concave shape in the CSD slope at small size fractions (Fig. 6.1.1). Particularly complexly shaped CSDs are observed in disseminated chromite textures in the footwall and in the middle of the massive UG2 Chromitite (Fig. 6.1.1). Orthopyroxene oikocrysts bearing chromite chadacrysts appear to preserve evidence for *in-situ* crystallisation of an earlier population of chromite, characterised by high nucleation densities and steep CSD slopes, like those reported by Kaufmann et al. (2018). Veksler et al. (2018) also noted that the relatively highest nucleation rates among chromite grains occur in chromite hosted in oikocrysts, specifically in samples of UG2 Chromitite, as observed here too (Fig. 6.1.1). One CSD in the uppermost massive UG2 Chromitite exhibits a well-developed kink, suggesting the presence of two distinct crystal populations (Fig. 6.1.1). Overall, the CSD data shown in Figure 6.1.1 do not support the idea of crystal settling of one large batch of chromite from the magma to form the massive chromitite nor do they suggest significant postcumulus modification. Instead, we emphasize the variation in CSD shapes and slopes across the entire UG2 unit, pointing to a texturally heterogeneous package of rock in terms of chromite grain size with no correlation between size and stratigraphic position observed. It is possible that this textural heterogeneity supports models arguing for incremental construction of the UG2 Chromitite (e.g., Junge et al. 2014).

In addition to the CSD evidence for postcumulus textural modification, petrographic observations are consistent with late-stage disequilibrium-driven crystallisation during the formation of the massive UG2 Chromitite. This conclusion is based on the presence of reaction rims, dissolution-reprecipitation textures and irregular complex optical zoning of intercumulus plagioclase. In detail, μm -scale plagioclase rims occur at the interfaces of chromite and orthopyroxene the footwall pyroxenite (Fig. 4.1.1, 4.1.2), matching the shapes of the chromite crystals they armor. This indicates disequilibrium between chromite and orthopyroxene. In the Rum intrusion, a similar texture has been reported to occur between olivine and chromite and interpreted to suggest postcumulus peritectic reaction in chromitite (Hepworth et al. 2020). Ubiquitous dissolution-reprecipitation textures in chromite in the footwall and lower massive chromitite including in particular intricate fishhook-type apophyses along chromite grain boundaries also point to disequilibrium conditions during chromite crystallisation (Fig. 4.1.4, Yudovskaya et al. 2019). Dissolution-reprecipitation textures such as these have been attributed

to chemical and thermal changes within the magmatic system, in particular for chromitites in the northern lobe of the Bushveld Complex where metasomatic replacement was suggested (Yudoyksaya et al. 2019).

Compositional variation in intercumulus plagioclase also points to a complex solidification history for the interstitial melt in the chromitite mush. We see optical zoning in intercumulus plagioclase as a relatively common feature in our samples, particularly in the footwall and lower massive chromitite plagioclase. Chemical zoning in intercumulus minerals has been linked to a trapped liquid shift effect (e.g., Veksler et al. 2018; Latypov et al. 2023); so such a process might explain some of the more systematic zoning patterns we observe (Fig. 4.1.3). However, the highly irregular chemical zoning picked out by our element mapping in Sample 2.1B might be interpreted to reflect a more complex late-stage history (see Fig. 6.4.1). The latter textures appear to reflect localised dissolution of plagioclase, probably at relatively high temperature since we see no evidence of hydrous alteration products of plagioclase associated with these areas. (Hepworth et al. 2020) attributed similarly complex textures in intercumulus plagioclase to sustained reactive percolation of interstitial melt in the crystal mush, but on this basis alone it is not possible to distinguish between a melt or a high-temperature fluid as the metasomatizing agent.

In further support of the open system behaviour of the UG2 Chromitite at the crystal mush stage, our *in-situ* initial $^{87}\text{Sr}/^{86}\text{Sr}$ measurements suggest the presence of isotopic heterogeneity in the intercumulus plagioclase throughout the sequence. It is important to reiterate that the plagioclase targeted for LA-ICPMS shows no evidence for secondary alteration at low temperature, petrographically or compositionally (see quantitative mineral chemical analyses in appendix table A6). It is not possible that crystallisation from a single batch of mixed or relatively primitive magma, differentiated or not, could explain such $^{87}\text{Sr}/^{86}\text{Sr}$ heterogeneity. Therefore, there must have been two isotopically distinct components present at the postcumulus stage. Two plausible end members sandwiching the range of Sr isotopic compositions we see here are the mantle-derived B1 parental melt to the Bushveld Complex (initial $^{87}\text{Sr}/^{86}\text{Sr}$ value ~ 0.703 ; Karykowski et al. 2018) and preexisting cumulate formed from a previously crustally-contaminated parental melt, for which the Sr isotope composition of the non-chromite fraction of the UG2 chromitite might be a reasonable estimate (initial $^{87}\text{Sr}/^{86}\text{Sr}$ value of ~ 0.706 ; Schoenburg et al. 1999). Karykowski et al. (2018) also analysed Sr isotopes in intercumulus plagioclase and suggested that the variable isotopic signatures they observed were due to high temperature metasomatic replacement between the preexisting cumulate and percolating primitive melt at the postcumulus stage. Hepworth et al. (2020) interpreted Sr-isotope heterogeneity in intercumulus plagioclase in the Rum layered intrusion to reflect a similar process, involving reactive crystallisation within the crystal pile. On Rum this was supported by petrographic evidence for plagioclase dissolution and reaction textures (i.e., rims) of plagioclase between olivine and chromite. The combined evidence presented here therefore seems to point toward an episode of reactive percolation within the UG2 mush following accumulation of chromite. This interpretation has support from studies in the recent literature such as that of Veksler et al. (2018), who argued that the distribution of incompatible elements through the UG2 body suggested it remained permeable for a relatively protracted period of time. Other studies have argued for a complex and protracted post accumulation cooling history of the UG2 Chromitite

(e.g., Mathez and Mey 2005; Junge et al. 2014), so we suggest our new data lend further weight to this line of argument.

Hepworth et al. (2020) reported that intercumulus plagioclase with a more An-rich composition was associated with chromite crystallisation. Those authors argued for a peritectic reaction between primitive melt and Na-rich plagioclase to produce chromite and anorthitic plagioclase in the Rum layered intrusion, producing compositional zoning similar to that observed in the An-content of interstitial plagioclase across our UG2 core (Fig. 6.5.1.1). However, the Rum chromitite seams are relatively thin (~mm scale) compared to the UG2 Chromitite, and it is possible to link field observations over relatively short distances (~100s m) to relate the chromitite seams to their hanging wall and footwall rocks (Hepworth et al. 2017;2018). Although we can use our current observations to make inferences on the postcumulus processes operating within the crystal mush represented by our specific core, the size (~100s km strike length) and significant lithological variation of the UG2 Chromitite make extrapolation of our interpretations to the scale of the Bushveld Complex more generally a risky proposition, particularly when it comes to elucidating the primary drivers for chromite crystallisation and accumulation. In agreement with Mathez and Mey (2005), we suggest that variation in the character of the associated hanging wall and footwall rocks is key to understanding UG2 Chromitite petrogenesis. For example, anorthosite occurs both above and below the chromitite in the samples studied by Robb and Mungall (2020), occurs as a relatively thick (up to 20 cm) layer in the section reported by Mathez and Mey (2005), and is present as a small (~1 cm) lens in our core. It is not clear how anorthosite might develop in this way in models involving gravity settling or slurry emplacement, but anorthosite assimilation by incoming magma has been suggested as a trigger for the *in-situ* crystallisation of chromitite in the Rum layered intrusion (O'Driscoll et al. 2010), so such a line of inquiry might bear further testing in the context of the UG2 Chromitite.

The apparent dihedral angle is a measure of textural maturity and therefore can be used to constrain the sub-solidus cooling history of cumulate rocks (Elliott et al. 1997; Holness et al. 2007; Holness et al. 2023). Dihedral angle variation is dependent on the interfacial energy at grain boundaries and, therefore, can provide insight on the thermodynamics of magmatic systems (Gokhale and Zhang 2013). Here, we consider that a single true distribution (Fig. 6.3.2) for a median apparent dihedral angle reflects the attainment of textural equilibrium (Holness et al. 2005; Holness et al. 2023). The results presented in Figures 6.3.1 and 6.3.2 suggest microstructures (chromite-chromite-plagioclase) that are all partly equilibrated because all deviate from the distribution that might be expected for a single true median angle. Our results also suggest that the triple junction angles between chromite-chromite-chromite phases are better texturally equilibrated because angle populations approach 120°. The chromite-chromite-chromite seem to have equilibrated faster than the apparent chr-chr-pl angle, which is to be expected for monomineralic triple junctions (Vernon 2018). In addition, the chromite-chromite-chromite samples are much more similar in Kurtosis to the true distribution of equilibrated angles whereas the chromite-chromite-plagioclase differ more significantly from the true distribution (Fig. 6.3.1).

The degree of textural maturation expressed by median apparent dihedral angle may also be considered in terms of the two endmembers of impingement and textural equilibration

(Holness et al. 2005). The original impingement by crystal growth may be modified in attempt to achieve solid-state equilibrium (Holness et al. 2005), leading to higher median apparent dihedral angles in comparison to the initial impingement value. The stepwise change in chromite-chromite-plagioclase dihedral angle at the footwall to the lower massive chromitite contact (Fig. 6.2.1) may indicate a change from a relatively unmodified impingement angle of $\sim 63^\circ$ in the footwall to $\sim 72^\circ$ in the lower massive UG2. This conclusion is supported by the petrographic observation that there is a tendency for chromite-chromite-plagioclase apparent dihedral angles to exhibit widening of the initial impingement angles in the lower massive chromitite (Figure 4.1.7). However, it is important to note that we observe both initial impingement and modified angles may present in both the footwall and lower massive groups, and we rely on our ~ 300 angle measurements per sample to quantify the difference (Fig. 6.2.1). The upper massive UG2 Chromitite generally displays relatively greater median apparent dihedral angles, like those in the lower massive UG2 Chromitite, with minor modification towards equilibrium in the solid-state (Figs. 4.1.7, 4.2.4), so we interpret the upper UG2 Chromitite to also reflect partly equilibrated textures.

Holness et al. (2007b) proposed that modification of impingement angles leading to a stepwise pattern in the median apparent dihedral angles occurs when the crystallisation of a new liquidus phase occurs (Fig. 7.1.1). The stepwise change occurs at, or close to, a change in cumulate lithology or a lithological boundary, like that at footwall contact.

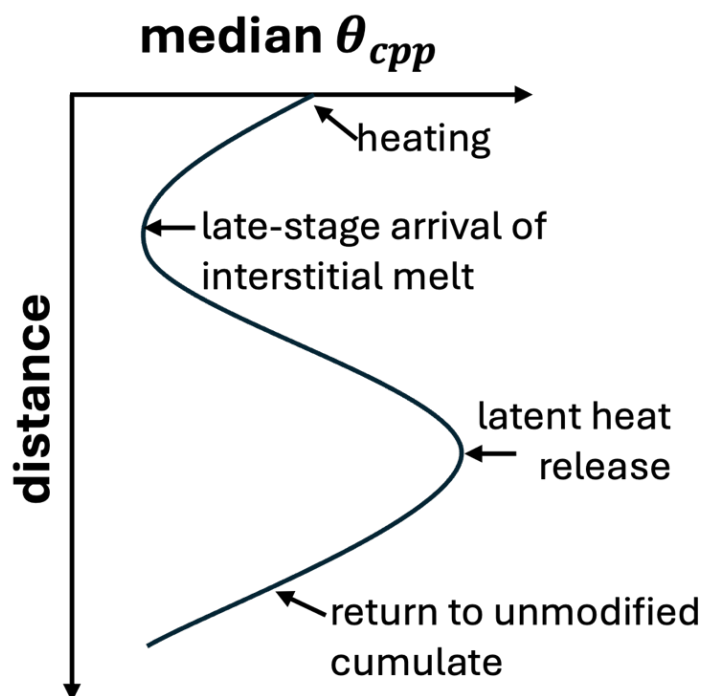


Figure 7.1.1. Median apparent dihedral angle variation across some distance which the suggested controls sigmoidal variation in textural maturity based on that presented by Holness et al. 2007a.

The enthalpy budget of the magma chamber is governed by the sensible heat (true temperature) and the latent heat (energy absorbed/released). The sensible heat of the system decreases when a new phase crystallizes by fractional latent heat (Holness et al. 2007a; Holness et al. 2007b; Holness 2010). Holness et al. (2007b) linked the relationship between fractional latent heat to a sigmoidal curve of the statistical median apparent dihedral angle as a function of relative distance in the stratigraphy (Fig. 7.1.1). Based on the results presented in Figure 6.2.1, we suggest that the stepwise change close to the base of the lower massive chromitite might reflect the latent heat of abundant crystallisation of chromite. If this interpretation holds, then the implication is that the chromitite does not represent a cargo of chromite brought in from elsewhere, which is what would be expected for a slurry model. Instead, the step-change in apparent dihedral angle is better representative of *in-situ* chromite crystallisation.

Areas of uncertainty remain in linking the geochemical and textural datasets. The former, together with some of the microstructural observations, support postcumulus modification. The CSD data show textural heterogeneity across the UG2 unit, and though likely preserve some primary nucleation and growth information (e.g., chromite in the orthopyroxene oikocrysts), the extent to which the shapes and slopes of the CSDs might have been modified by the aforementioned postcumulus processes remains somewhat of an open question. If we interpret the step change in our dihedral angle data at the chromitite footwall contact in the same way as other authors (e.g., Holness et al. 2007b), then this reflects a primary crystallisation signature that we can use to argue for *in-situ* crystallisation of this part of the UG2 Chromitite. However, if the reactive percolation processes argued for above have somehow caused modification of the dihedral angles, then the issue is far from resolved. Future work might profit from evaluating if late-stage modification of dihedral angles in this manner is a realistic prospect.

7.2 The leader seam as a unique crystallisation event?

The leader seam is a thin package of massive chromitite overlaying the main UG2 Chromitite seam (Naldrett et al. 2009; Maier et al. 2016; Veksler et al. 2018; Maier & Barnes 2024). Some authors have described the formation of the leader seam to have occurred as a sill-like bifurcation from the underlying main seam (Maier et al. 2016; Latypov et al. 2017; Mathez & Kinzler 2017; Maier & Barnes 2024).

In the MZK130-D2 core, the leader seam exhibits evidence of a similar reaction textures as the main UG2 layer. This includes chromite textures such as embayments and fishhooks (Fig. 4.2.2). Compositional heterogeneity is observed in intercumulus plagioclase, with evidence in our mineral chemical maps for complex zoning (Fig. 6.4.2), albeit to a lesser extent than in the UG2 Chromitite (Fig. 6.4.1). Nonetheless, there is an association between Ca enrichment and Na depletion and the zoning observed in plagioclase (Fig. 6.4.2), as might be expected from primary magmatic zoning. The leader seam footwall also reveals Sr isotope heterogeneity like that observed in the footwall and lower massive UG2 (Fig. 6.6.4).

There is also significant variation in the CSD results for the leader seam chromite (Fig. 6.1.1). Generally, the samples in the leader seam indicate a comparable nucleation rate to the UG2 Chromitite. The curves are broadly log-linear with minor evidence for textural annealing

(Fig. 6.1.1). Like the UG2, leader seam orthopyroxene oikocrysts also point to *in-situ* nucleation and growth during an earlier crystallisation event characterized by higher nucleation rates and less subsequent textural annealing (Kaufmann et al. 2018). The topmost chromite making up the leader seam (sample 9.4B) reveals complex curvature in the CSD plot (Fig 6.1.1). This plot highlights how texturally heterogeneous the leader seam chromite populations are and may suggest presence of multiple populations during *in-situ* crystallisation. In terms of apparent dihedral angle variation, the chromite-chromite-plagioclase angle remains relatively consistent through the middle and upper massive UG2 Chromitite, and even into the base of the leader seam (which has a value of $\sim 84^\circ$). However, the interior of the leader seam is characterised by step change to lower angles ($68-70^\circ$), before stepping back up to $\sim 85^\circ$ at the top of the leader seam. Although we do not fully understand the complexity of the apparent dihedral variation over the small thickness of cumulate associated with the leader seam, we suggest one interpretation of the data is that it represents a separate crystallisation event to that of the main UG2 Chromitite layer, and may have experienced late-stage percolation of interstitial melt as per Figure 7.1.1. Microstructural support for this interpretation may be provided by the continuous layer of conjoined oikocrysts in the interior of the leader seam.

The crystal-rich slurry model was originally proposed by Mondal & Mathez (2007) for the formation of massive chromitites. Deposition of this crystal cargo was originally interpreted to be a basal injection along a cumulate floor (Mondal & Mathez 2007), although this idea has been reimaged as a sill-injection under a cumulate pile that is several dozens of metres thick (Maier et al. 2016; Latypov et al. 2017). Importantly, the latter mode of formation would not allow chemical exchange with the overlying magma body (Latypov et al. 2017). As a result, it will crystallize under equilibrium conditions producing intercumulus plagioclase with a homogeneous composition (Latypov et al. 2017). Given the results of An-content (Fig. 6.5.1.1) and Sr isotope variation (Fig. 6.6.4) in interstitial plagioclase in the leader seam and its footwall (i.e., the norite break), we suggest significant communication and chemical exchange involving plagioclase components at the postcumulus stage, so we find little in our dataset to support a slurry model, for this portion of the UG2 Chromitite at least.

8. Conclusions

Massive chromitites hosted in layered mafic-ultramafic intrusions are the focus of ongoing debate regarding their petrogenesis and the implications for the crystallisation of layered intrusions more generally. The UG2 in the Bushveld Complex is a classic example of massive chromitite in a layered intrusion, with global significance in terms of base- and precious metal mineralisation. In an attempt to elucidate the formation of massive chromitite with specific reference to the mechanisms responsible for the development of the UG2, we have investigated microtextural and mineral chemical variations in a core transect from the western lobe of the Bushveld Complex. Microstructural observations suggest postcumulus disequilibrium between minerals; specific lines of evidence include the presence of reaction rims and dissolution-reprecipitation textures in chromite. These results go together with the heterogeneity observed in intercumulus plagioclase $^{87}\text{Sr}/^{86}\text{Sr}$, which suggests that multiple isotopic signatures present at the postcumulus stage. Quantitative textural data point to significant heterogeneity in the grain size distributions of chromite through the UG2 unit, perhaps supporting models of incremental construction of the massive chromitite. Our apparent dihedral angle data reveal a marked positive step change close to the base of the chromitite, that we suggest reflects *in-situ* crystallisation of chromite and poses issues for formation of the UG2 Chromitite in this part of the Bushveld Complex by slurry emplacement. In summary of our main finding, we argue for an important stage of reactive crystallisation involving percolating interstitial melt or fluid at the postcumulus stage in the UG2 Chromitite, meaning that the UG2 chromite mush was an open system following its initial accumulation.

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Appendix

Table A1. CSD results for samples in core MZK130-D2. Note that there are samples that lack a σ -error for the slope and interception of their respective linear regressions because these values were not output by CSDCorrections.

Group	Sample	V_d^A	ϕ^B	$A \text{ (mm}^2\text{)}^C$	n	roundness	R^2	$\Sigma m^D \pm \sigma$	$\Sigma b^E \pm \sigma$	Big 'R'	Q^F	C_l^G	σ_s^H
footwall	1.2	9.9	90.2	220.3	665	0.2	1.0	-12.6	6.0	0.8		0.1	0.9
	1.6A	63.5	36.5	72.1	517	0.2	1.0	-6.4 ± 0.3	5.4 ± 0.1	1.5	0.0	0.2	0.9
	1.6B	62.3	37.7	65.7	387	0.3	1.0	-6.3 ± 0.4	5.5 ± 0.2	1.5	0.0	0.2	0.9
	1.6C	14.9	85.1	29.9	217	0.1	1.0	-14.5 ± 1.0	7.2 ± 0.2	1.2	0.6	0.1	1.0
lower massive	2.1A	61.3	38.7	22.0	420	0.1	1.0	-11.3	7.4			0.1	1.0
	2.1Oik	9.3	90.7	75.9	385	0.2	1.0	-14.8 ± 0.8	6.8 ± 0.2	1.2	0.4	0.1	0.9
	2.1B	51.7	48.3	63.7	611	0.2	1.0	-9.5 ± 0.4	6.7 ± 0.1	1.5	0.0	0.1	0.9
	2.2A	61.9	38.1	19.8	321	0.3	1.0	-9.8 ± 0.6	7.1 ± 0.2	1.4	0.6	0.1	0.9
	2.2B	61.1	38.9	30.4	363	0.3	1.0	-9.4 ± 0.6	7.0 ± 0.2	1.4	0.0	0.1	0.9
middle massive	3.1	60.7	39.3	20.9	336	0.1	1.0	-13.1	7.8	1.5		0.1	1.0
	3.11	57.9	42.1	27.9	362	0.1	1.0	-11.7	7.3	1.5		0.1	1.0
	6.3	61.6	38.4	24.1	367	0.1	1.0	-13.0	7.7	1.5		0.1	1.0
upper massive	7.2A	65.2	34.8	37.9	428	0.3	1.0	-7.7	6.1	1.4		0.1	0.9
	7.2B	19.7	80.3	59.8	745	0.3	1.0	-14.5	7.6	1.1		0.1	0.9
leader seam	9.2_oik	14.6	85.4	20.1	663	0.3	1.0	-35.1	10.7	1.2		0.0	0.9
	9.3A	70.2	29.8	24.0	361	0.3	0.9	-10.0	6.8	1.4		0.1	0.9
	9.3B	67.7	32.3	46.9	440	0.3	1.0	-6.8	5.7	1.4		0.2	0.9
	9.4A	60.5	39.5	30.9	434	0.3	0.8	-8.6	6.1	1.4		0.1	0.9
	9.4B	11.7	88.3	113.7	505	0.3	1.0	-9.5	5.7	0.9		0.1	0.9

^A Volumetric phase proportion (%)

^B Porosity (%)

^C Measured area (mm²)

^D Slope of the linear regression

^E Y-Intercept of the linear regression

^F Goodness of fit

^G Characteristic length

^H Shape factor

Table A2. Results for apparent dihedral angle (chr-chr-pl) results for samples in core MZK130-D2.

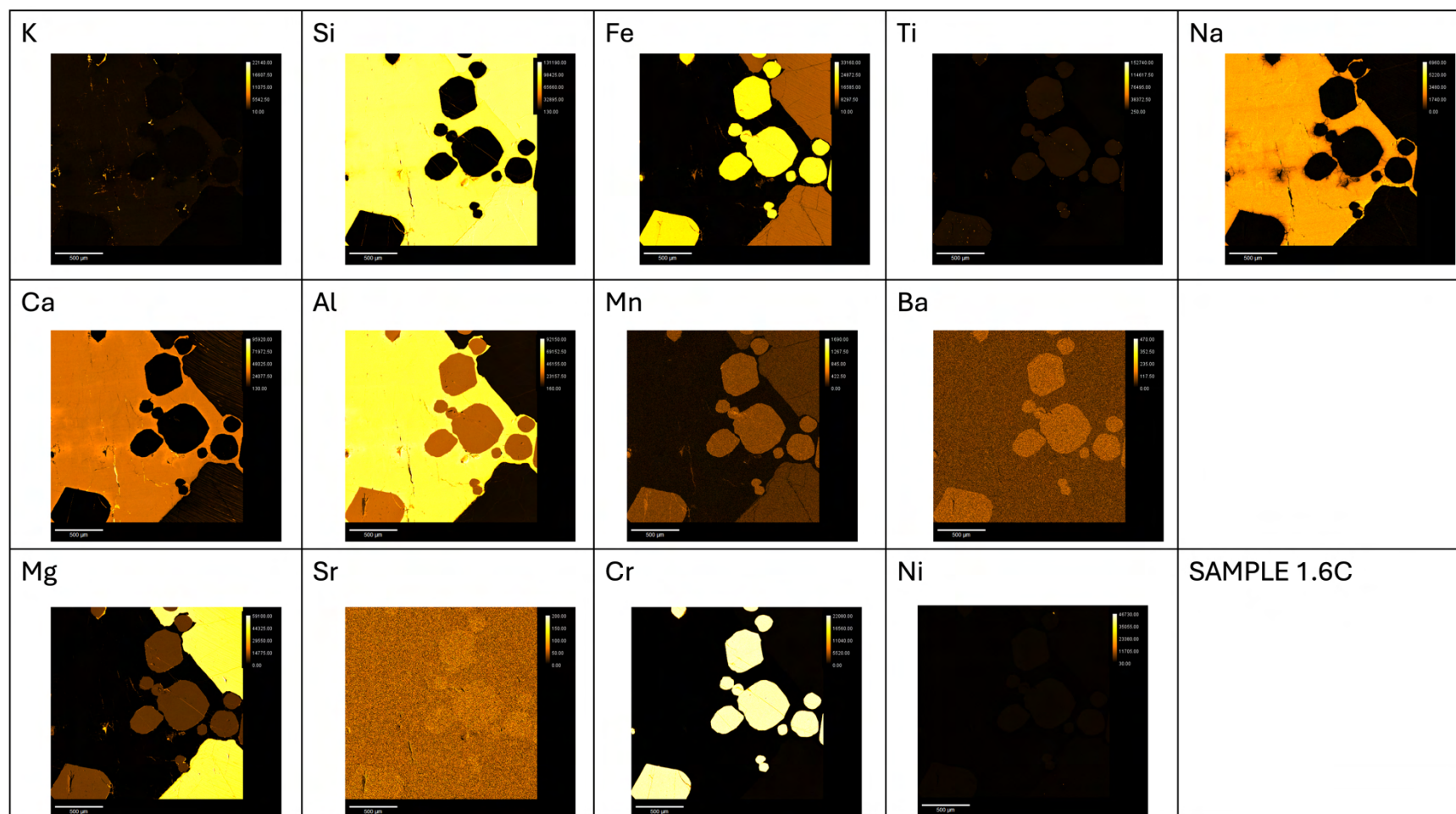
	1.2	1.6C	1.6A	1.6B	2.1A	2.1oik	2.1B	2.2A	2.2B	3.1	3.11	6.3	7.2a	7.2b	9.2oik	9.3a	9.3b	9.4a	9.4b
Depth (m)	590.3	590.1	590.1	590.1	590.1	590.1	590.0	590.0	590.0	589.7	589.4	589.0	588.9	588.9	588.7	588.7	588.7	588.7	588.6
Mean (°)	75.1	66.2	69.6	67.1	68.6	91.9	73.4	74.4	71.4	75.6	73.8	73.5	79.3	77.4	83.3	70.3	69.0	69.7	84.7
Standard Error	1.5	2.3	1.4	1.7	1.5	1.8	1.3	1.6	1.5	1.6	1.6	1.5	1.6	1.5	1.6	1.6	1.6	1.5	1.5
Median (°)	73.0	61.7	66.0	63.4	67.3	91.7	72.4	72.0	71.2	75.5	72.9	72.7	78.1	76.6	82.5	68.6	65.5	66.5	84.5
Mode (°)	116.6	72.3	94.4	48.4	63.4	90.0	90.0	89.0	90.0	90.0	90.0	90.0	63.4	109.7	90.0	90.0	90.0	90.0	90.0
Standard Deviation	25.7	25.2	25.8	28.6	28.0	26.7	24.2	27.7	26.5	27.0	28.4	25.3	27.5	27.0	27.6	28.5	26.9	25.7	25.2
Sample Variance	662.7	635.6	664.6	817.9	784.3	712.0	586.2	765.7	703.3	729.4	808.1	641.1	754.2	730.6	764.4	813.8	726.3	661.5	635.3
Kurtosis	-0.5	0.7	-0.3	-0.5	-0.6	-0.5	-0.5	-0.6	-0.7	-0.5	-0.5	0.2	-0.2	-0.6	-0.6	-0.3	-0.2	0.0	-0.6
Skewness	0.4	0.8	0.4	0.4	0.3	-0.1	0.2	0.3	0.3	0.2	0.2	0.6	0.2	0.3	0.2	0.5	0.6	0.5	0.1
Range (°)	117.5	139.7	127.9	133.3	142.8	126.3	115.3	130.9	115.7	133.7	148.7	133.0	146.1	128.9	138.8	134.4	136.0	153.5	130.0
Minimum (°)	22.4	14.6	9.8	17.6	11.8	27.4	22.6	20.0	19.3	19.3	17.3	19.6	17.0	21.0	22.3	16.6	13.6	14.4	28.5
Maximum (°)	140.0	154.3	137.7	150.8	154.6	153.6	137.9	150.9	135.0	153.0	166.0	152.6	163.1	149.8	161.1	150.9	149.6	167.9	158.5
Sum	23569.7	7811.2	24214.7	19929.1	24775.2	20136.2	24947.8	22997.3	22792.5	22690.8	22216.1	22197.8	23879.7	23622.0	25230.1	21848.0	20852.0	21057.1	25567.9
Count (n)	314.0	118.0	348.0	297.0	361.0	219.0	340.0	309.0	319.0	300.0	301.0	302.0	301.0	305.0	303.0	311.0	302.0	302.0	302.0

Table A3. Results for apparent triple junction (chr-chr-chr) results for samples in core MZK130-D2.

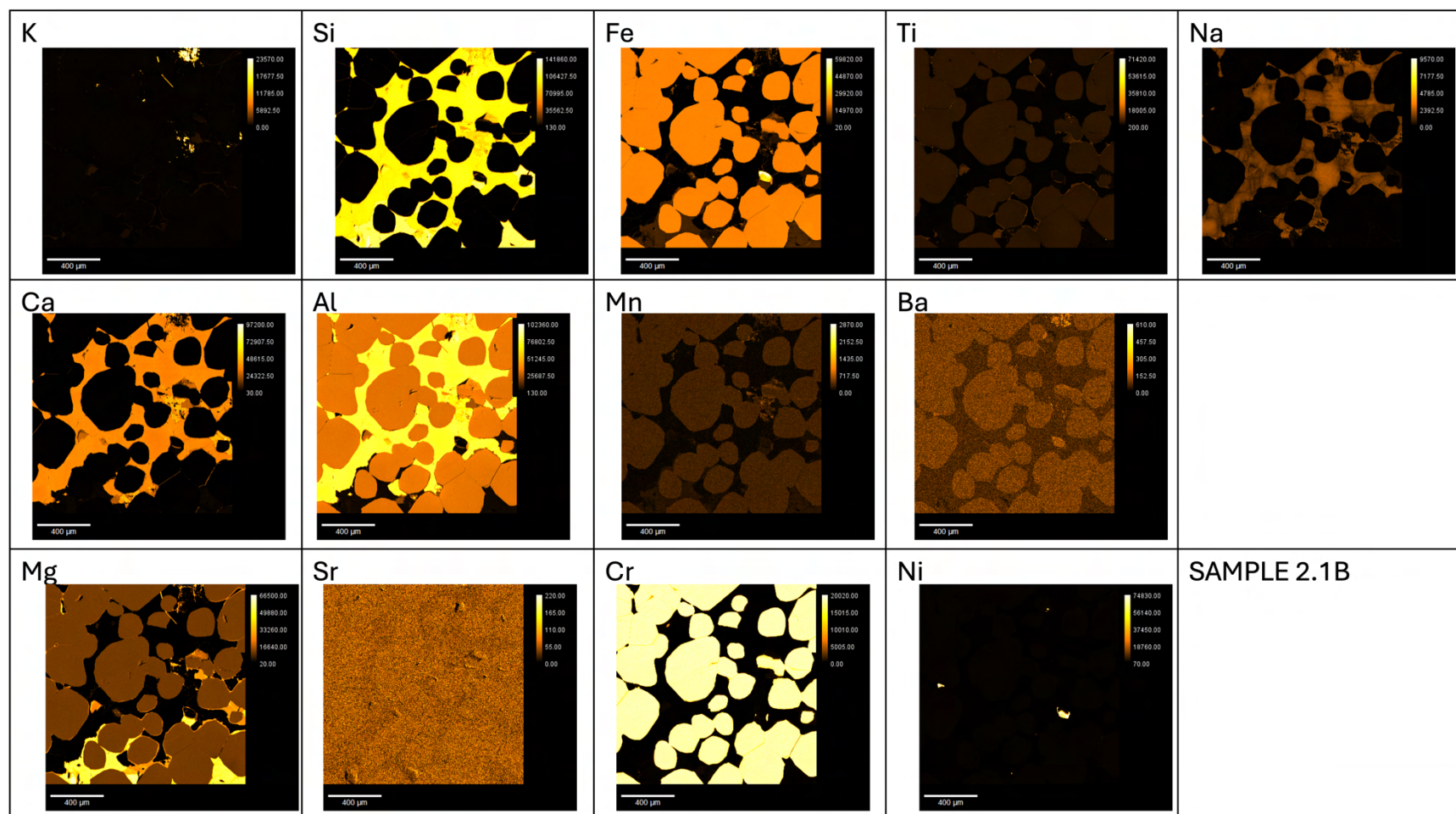
	3.1	3.11	6.3	9.3
Depth (m)	589.7	589.4	589.0	588.7
Mean (°)	119.1	118.2	119.4	118.6
Standard Error	1.0	1.0	1.1	1.0
Median (°)	120.1	118.5	120.3	120.9
Mode (°)	137.4	131.8	119.7	126.9
Standard Deviation	16.8	18.1	18.5	17.3
Sample Variance	282.9	328.8	341.4	299.8
Kurtosis	0.2	0.3	0.9	0.3
Skewness	-0.3	-0.4	-0.4	-0.5
Range (°)	92.9	110.6	118.4	106.8
Minimum (°)	67.7	59.6	43.9	60.5
Maximum (°)	160.6	170.2	162.3	167.3
Sum	36209.5	35803.5	36047.4	36178.6
Count (n)	304.0	303.0	302.0	305.0

Table A4. Results for expected true apparent dihedral angles results for a given median angle value.

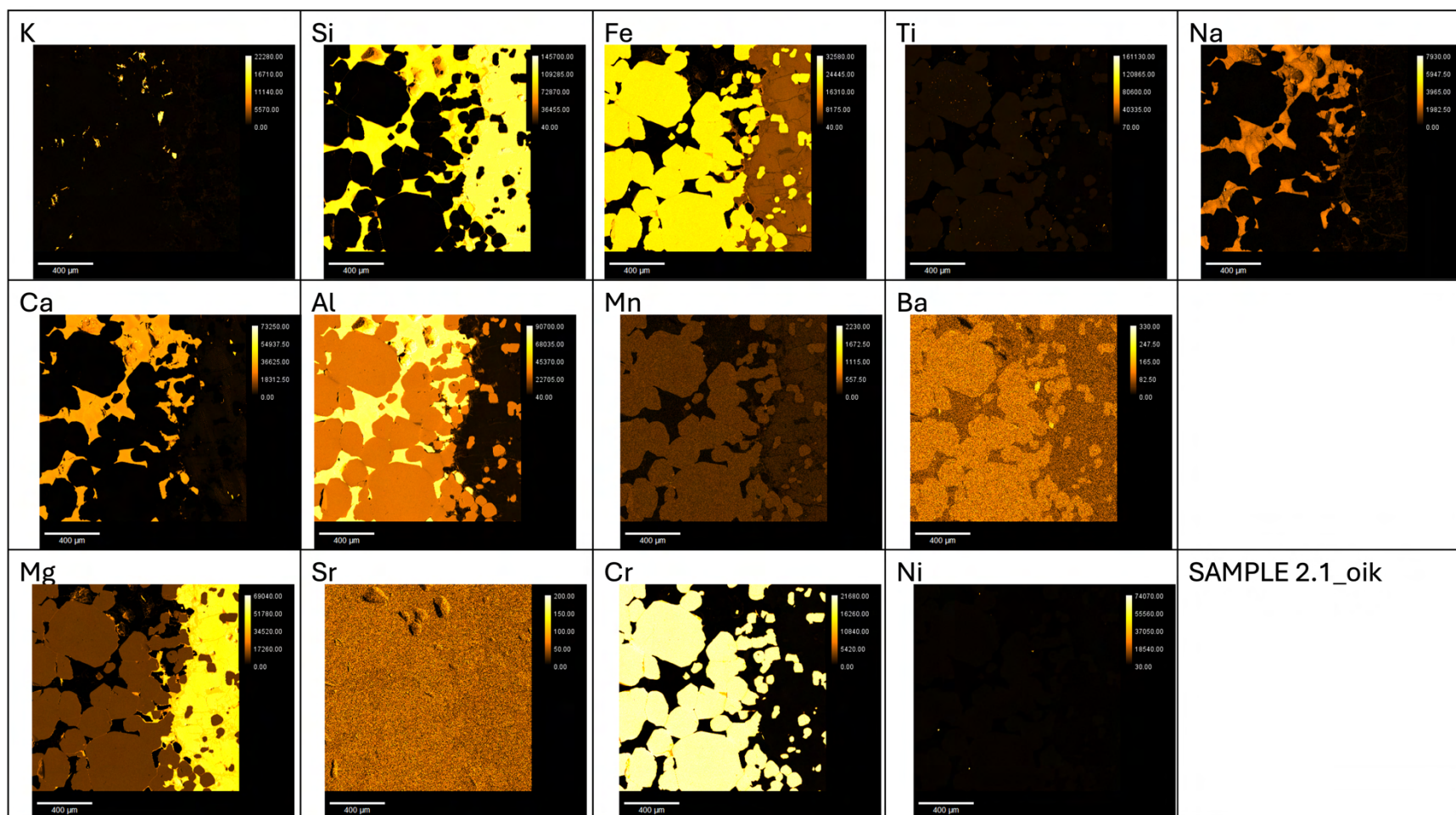
[illegible]



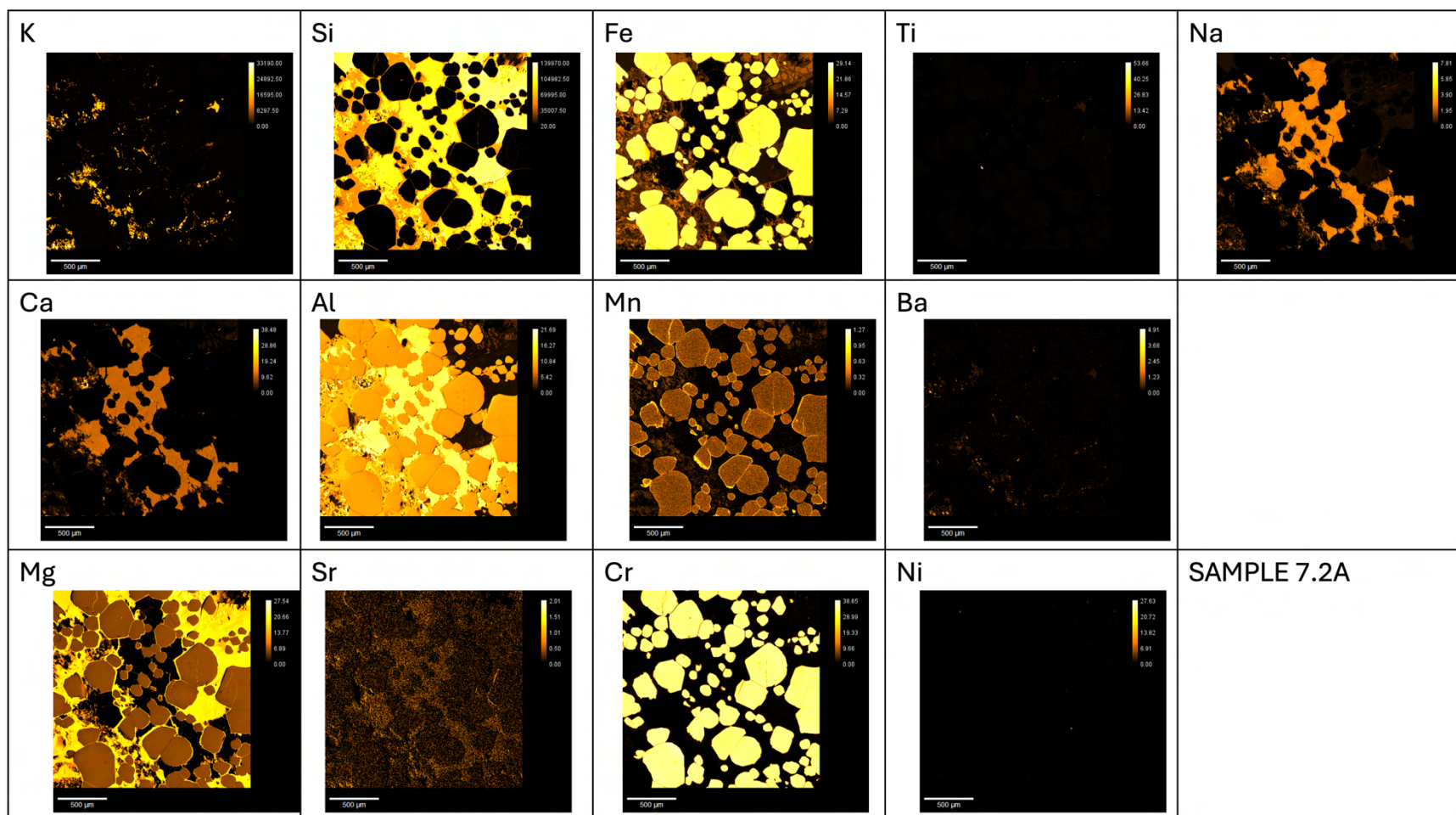
Appendix: Figure 1. Sample 1.6C element maps. Note that the units for these values are raw x-ray counts.



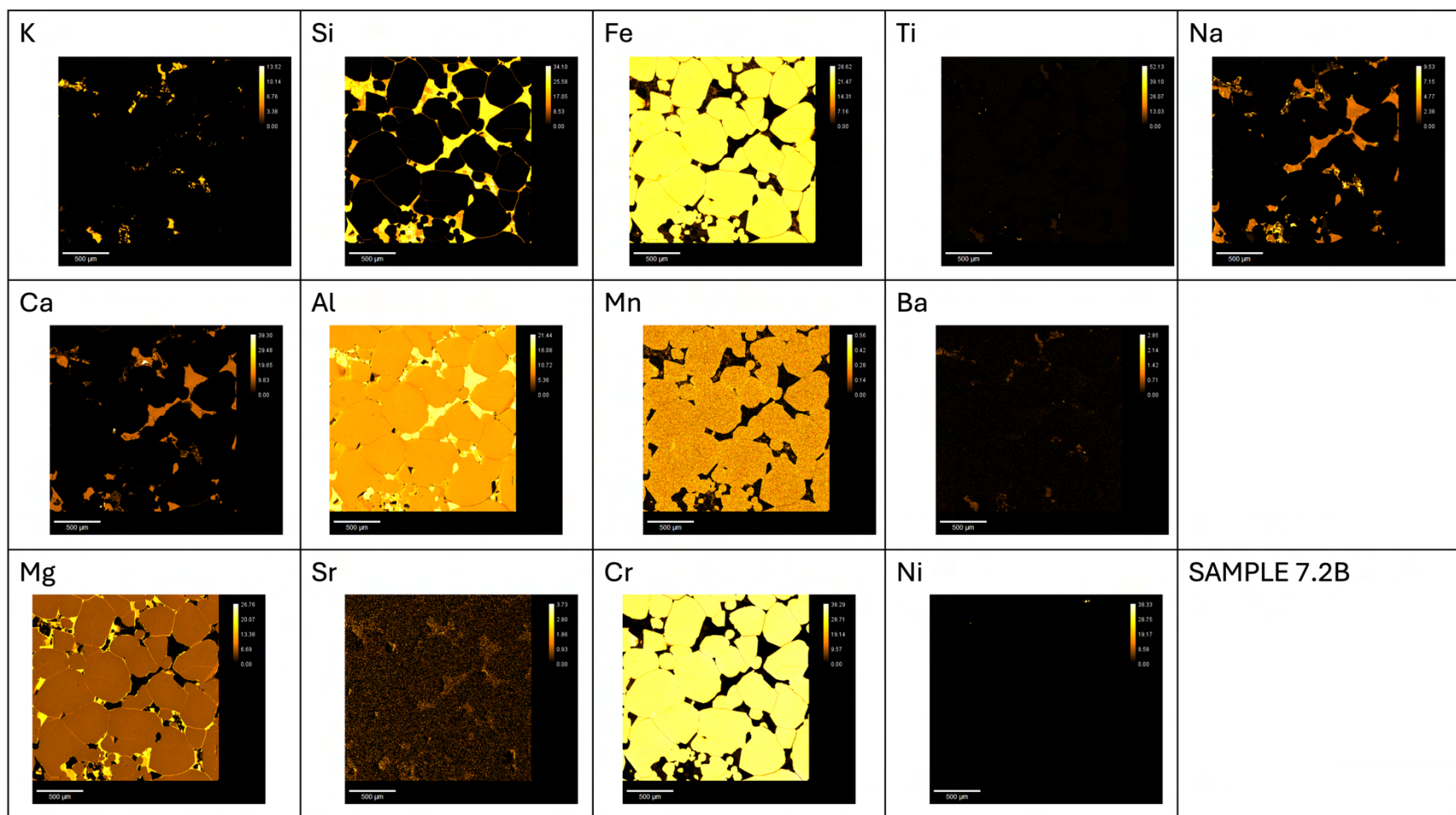
Appendix: Figure 2. Sample 2.1 element maps. Note that the units for these values are raw x-ray counts.



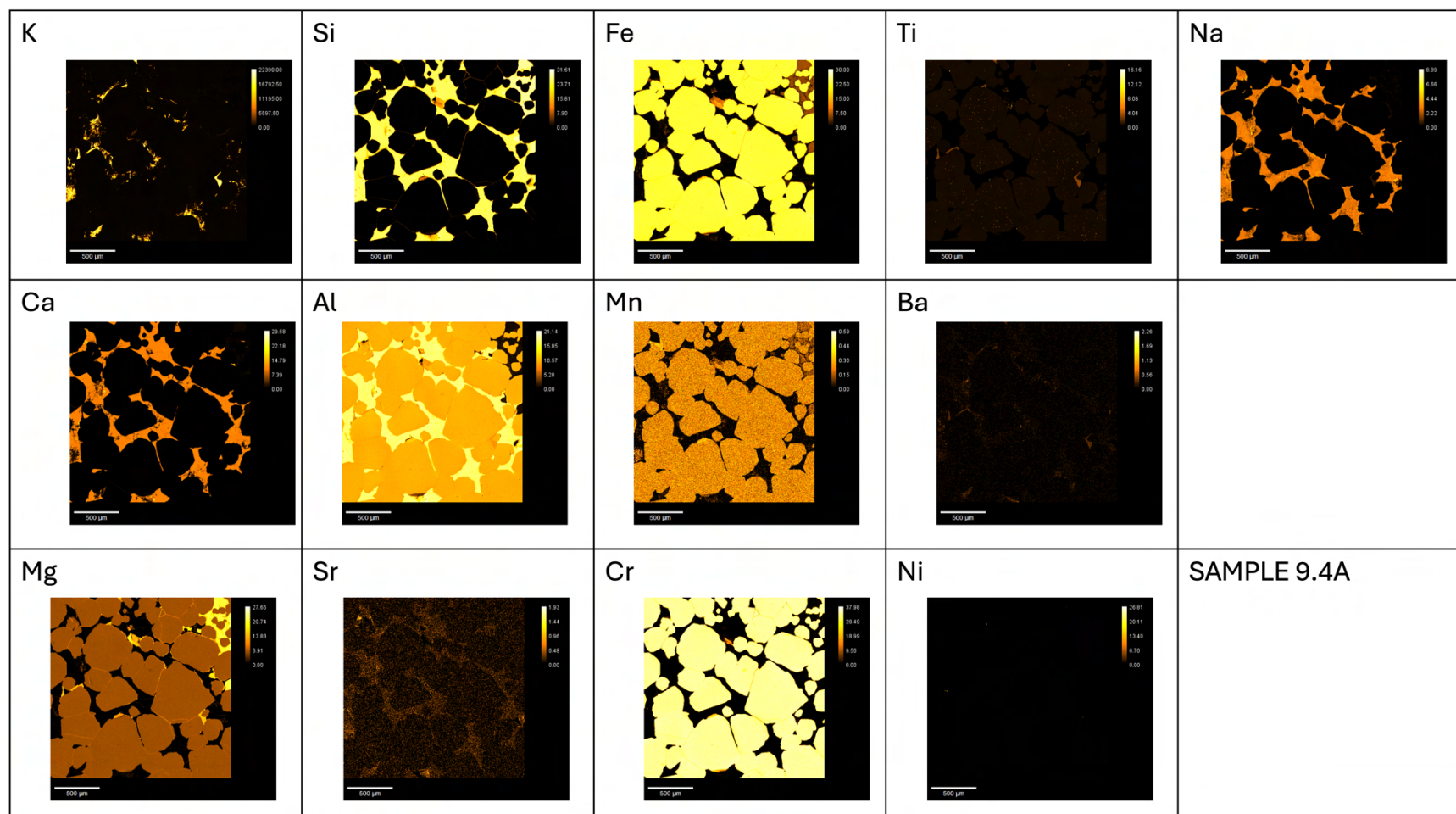
Appendix: Figure 3. Sample 2.1_oik element maps. Note that the units for these values are raw x-ray counts.



Appendix: Figure 4. Sample 7.2A element maps. Note that the units for ‘K’ and ‘Si’ are raw x-ray counts and for the rest of are wt. %.



Appendix: Figure 5. Sample 7.2B element maps. Note that the units are wt. %.



Appendix: Figure 6. Sample 9.4A element maps. Note that the units for ‘K’ are raw x-ray counts and for the rest of are wt. %.

Table A5. Results for *in-situ* LA-ICPMS for $^{86}\text{Sr}/^{87}\text{Sr}$ isotopes. Note that the italicized font represents samples which $^{87}\text{Sr}/^{86}\text{Sr}$ values exceed the range of $0.0564\text{--}0.0567 \pm 0.0001$ and therefore were not included in their corrected initial $^{87}\text{Sr}/^{86}\text{Sr} \pm 2$ sigma error (se).

Sample	totalSr (V)	$^{87}\text{Rb}/^{86}\text{Sr}$	2 se	$^{87}\text{Sr}/^{86}\text{Sr}$	2 se	$^{84}\text{Sr}/^{86}\text{Sr}$	2 se	$^{87}\text{Sr}/^{86}\text{Sr}$ (initial)	2 se
Sample 1.6									
1.6-A - 1	2.54	0.001178	0.000103	0.706547	0.000071	0.056401	0.000124	0.706513	0.000071
1.6-B - 1	2.72	0.008340	0.000698	0.706538	0.000060	0.056592	0.000121	0.706296	0.000063
1.6-C - 1	2.45	0.001838	0.000128	0.706311	0.000070	0.056501	0.000127	0.706258	0.000070
1.6-D - 1	2.49	0.006336	0.001592	0.706319	0.000084	0.056452	0.000133	0.706135	0.000096
1.6-E - 1	2.65	0.010257	0.000797	0.706469	0.000072	0.056513	0.000121	0.706171	0.000076
1.6-F - 1	2.76	0.019962	0.001582	0.706522	0.000070	0.056481	0.000116	0.705942	0.000084
1.6-G - 1	2.84	0.017634	0.002709	0.706652	0.000075	0.056447	0.000117	0.706140	0.000109
1.6-H - 1	2.76	0.006048	0.000282	0.706484	0.000061	0.056270	0.000105		
1.6-I - 1	2.83	0.001959	0.000125	0.706312	0.000069	0.056377	0.000106		
1.6-J - 1	2.70	0.003271	0.000023	0.706267	0.000067	0.056331	0.000103		
1.6-K - 1	2.73	0.003273	0.000120	0.706392	0.000079	0.056338	0.000122		
1.6-L - 1	2.74	0.007247	0.001241	0.706376	0.000067	0.056408	0.000103	0.706165	0.000076
1.6-M - 1	2.73	0.003542	0.000033	0.706359	0.000063	0.056476	0.000102	0.706257	0.000063
1.6-N - 1	2.91	0.003033	0.000049	0.706376	0.000068	0.056466	0.000098	0.706288	0.000068
1.6-O - 1	2.85	0.055571	0.004039	0.707022	0.00009	0.056570	0.000168		
skipped P inadvertently									
1.6-Q - 1	2.92	0.015804	0.006379	0.706646	0.000102	0.055774	0.000160		
1.6-R - 1	2.30	0.000709	0.000079	0.706440	0.000107	0.055786	0.000168		
1.6-S - 1	0.82	0.032614	0.008180	0.706125	0.000184	0.064581	0.001456		
1.6-T - 1	1.69	0.012007	0.001852	0.706787	0.000112	0.056250	0.000402		
Sample 2.1									
2.1-A - 1	2.09	0.136647	0.015685	0.708414	0.000167	0.056195	0.000586		
2.1-B - 1	2.13	0.030637	0.003795	0.706828	0.000104	0.055840	0.000144		
2.1-C - 1	2.11	0.008646	0.001506	0.706435	0.000113	0.056341	0.000182		
2.1-D - 1	2.31	0.030897	0.007210	0.707127	0.000203	0.055735	0.000258		

2.1-E - 1	2.13	0.001469	0.000198	0.706364	0.000095	0.056296	0.000146	0.706322	0.000096
2.1-F - 1	2.06	0.002388	0.000383	0.706272	0.000063	0.056428	0.000146	0.706203	0.000064
2.1-G - 1	2.21	0.001121	0.000160	0.706258	0.000077	0.056530	0.000144	0.706226	0.000077
2.1-H - 1	2.16	0.000177	0.000019	0.706358	0.000065	0.056515	0.000138	0.706353	0.000065
2.1-I - 1	2.16	0.001246	0.000026	0.706274	0.000078	0.056361	0.000172	0.706238	0.000078
2.1-J - 1	2.25	0.008385	0.001334	0.706417	0.000063	0.056541	0.000136	0.706174	0.000074
2.1-K - 1	2.18	0.000902	0.000176	0.706340	0.000088	0.056541	0.000136	0.706314	0.000088
2.1-L - 1	2.24	0.008978	0.000692	0.706440	0.000065	0.056500	0.000136	0.706180	0.000068
2.1-M - 1	2.13	0.006919	0.000355	0.706389	0.000067	0.056472	0.000130	0.706188	0.000068
2.1-N - 1	2.28	0.003284	0.000668	0.706493	0.000068	0.056398	0.000130	0.706397	0.000071
2.1-O - 1	1.79	0.000466	0.000082	0.706386	0.000088	0.056540	0.000163	0.706372	0.000088
2.1-P - 1	2.19	0.025365	0.005169	0.706670	0.000083	0.056347	0.000168	0.705933	0.000171
2.1-Q - 1	2.31	0.000625	0.000135	0.706298	0.000088	0.056506	0.000133	0.706279	0.000088
2.1-R - 1	1.74	0.001394	0.000078	0.706351	0.000075	0.056294	0.000249		
2.1-S - 1	1.94	0.000605	0.000076	0.706481	0.000067	0.056623	0.000153	0.706463	0.000067
2.1-T - 1	2.25	0.000360	0.000024	0.706319	0.000076	0.056446	0.000142	0.706308	0.000076

Sample 8

8A - 1	3.34	0.011746	0.000947	0.706726	0.000062	0.056564	0.000101	0.706385	0.000062
8B - 1	3.18	0.001147	0.000023	0.706568	0.000049	0.056493	0.000101	0.706534	0.000049
8C - 1	3.27	0.023668	0.000922	0.706794	0.000059	0.056472	0.000099	0.706107	0.000059
8D - 1	3.49	0.012912	0.005162	0.706738	0.000102	0.056477	0.000114		
8E - 1	3.30	0.003621	0.000642	0.706606	0.000062	0.056326	0.000084		
8F - 1	3.67	0.045313	0.002483	0.707225	0.000081	0.056441	0.000072	0.705909	0.000081
8G - 1	2.28	0.009352	0.000631	0.706773	0.000065	0.056288	0.000130	0.706501	0.000065
8H - 1	3.00	0.023722	0.003166	0.706883	0.000127	0.055691	0.000283		
8I - 1	2.32	0.013482	0.000718	0.706642	0.000074	0.056334	0.000119		
8J - 1	2.37	0.157995	0.007855	0.708831	0.000111	0.056420	0.000213		
8K - 1	2.18	0.048086	0.004591	0.707263	0.000093	0.056260	0.000136	0.705867	0.000093
8L - 1	2.44	0.005270	0.000499	0.706673	0.000060	0.056187	0.000130		
8M - 1	2.34	0.006192	0.000900	0.706533	0.000071	0.056421	0.000147	0.706353	0.000071

8N - 1	2.50	0.004970	0.000026	0.706585	0.000083	0.056486	0.000136	0.706441	0.000083
8O - 1	2.50	0.013228	0.000430	0.706905	0.000060	0.056383	0.000120	0.706520	0.000060
8P - 1	2.40	0.070852	0.004170	0.707015	0.000078	0.056305	0.000139		
8Q - 1	2.41	0.010320	0.000118	0.706749	0.000060	0.056507	0.000120	0.706449	0.000060
8R - 1	2.28	0.008941	0.001751	0.706537	0.000087	0.056510	0.000109	0.706277	0.000087
8S - 1	2.26	0.016760	0.001552	0.706817	0.000077	0.056423	0.000128	0.706330	0.000077
8T - 1	2.34	0.022268	0.004185	0.706669	0.000062	0.056352	0.000167	0.706023	0.000062

Table A6. Electron probe microanalysis for spot analyses on plagioclase.

SAMPLE	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	SrO	BaO	Na2O	K2O	O	H2O	TOTAL
8.p1.plag	53.99	0.01	28.01	0.57	0.02	0.19	10.99	-	0.02	5.26	0.16	-	-	99.23
8.p1.plag	52.23	0.02	30.13	0.20	0.01	-	12.77	-	-	4.22	0.21	-	-	99.79
8.p1.plag	53.29	0.03	28.16	0.84	0.01	0.45	11.26	-	-	4.72	0.28	0.00	-	99.03
8.p1.plag	54.14	0.01	28.21	0.15	-	0.02	11.28	-	0.05	5.11	0.23	-	-	99.18
8.p1.plag	51.87	0.04	29.72	0.20	-	0.02	13.07	-	0.04	4.11	0.27	-	-	99.34
8.p2.plag	51.44	0.03	30.07	0.15	-	0.01	13.51	-	-	3.83	0.21	-	-	99.24
8.p2.plag	53.88	0.02	28.05	0.32	0.01	0.12	11.42	-	-	5.06	0.12	0.00	-	99.00
8.p2.plag	50.51	0.03	29.68	0.72	0.02	0.20	13.35	-	0.03	3.67	0.21	-	-	98.43
8.p2.plag	51.96	0.02	29.55	0.33	-	0.04	13.13	-	0.06	3.50	0.55	-	-	99.14
8.p2.plag	51.80	0.03	29.95	0.30	-	0.05	13.29	-	0.03	3.88	0.19	-	-	99.52
8.p3.plag	52.46	0.04	29.03	0.15	-	0.02	12.62	-	0.04	4.29	0.36	-	-	99.00
8.p3.plag	53.28	0.03	29.06	0.11	0.00	0.01	12.12	-	-	4.47	0.27	0.00	-	99.36
8.p3.plag	52.73	0.02	29.39	0.17	0.01	0.00	12.62	-	0.01	4.33	0.21	0.00	-	99.46
8.p3.plag	15.41	0.01	15.08	0.12	-	0.01	7.69	-	-	3.27	0.25	-	-	41.85
8.p3.plag	53.62	0.02	28.10	0.15	0.01	0.01	11.81	-	0.02	4.82	0.23	-	-	98.79
8.p3.plag	52.99	0.02	28.81	0.30	0.02	0.05	12.21	-	0.04	4.63	0.15	-	-	99.22
8.p3.plag	52.92	0.02	28.99	0.10	-	0.01	12.37	-	0.03	4.36	0.30	0.00	-	99.10
8.p3.plag	51.76	0.03	27.04	3.52	0.07	1.18	10.07	-	0.04	4.62	0.31	-	-	98.65
8.p3.plag	52.80	0.02	29.36	0.17	-	0.00	12.44	-	-	4.29	0.26	-	-	99.35
8.p3.plag	52.52	0.02	25.98	3.35	0.03	1.13	10.15	-	0.00	4.73	0.12	-	-	98.04
8.p4.plag	50.73	0.01	25.80	4.45	0.04	2.55	10.13	-	0.06	3.85	0.16	-	-	97.79
8.p4.plag	53.28	0.03	29.61	0.14	-	0.02	12.30	-	0.09	4.40	0.27	-	-	100.15
8.p4.plag	40.27	0.03	26.44	3.94	0.48	0.86	20.77	-	-	1.06	0.03	-	-	93.89
8.p4.plag	51.02	0.02	26.54	3.75	0.04	2.12	10.44	-	-	4.08	0.19	0.00	-	98.21
8.p4.plag	53.01	0.04	29.55	0.11	0.03	0.00	12.55	-	0.08	4.53	0.21	-	-	100.11
8.p4.plag	-	1.12	14.81	31.90	0.33	6.45	0.05	-	-	-	0.02	0.00	-	54.69
8.p4.plag	52.95	0.02	29.04	0.19	0.01	0.03	12.31	-	0.04	4.47	0.17	0.00	-	99.24
8.p4.plag	52.43	0.01	29.04	1.12	0.01	0.44	12.23	-	-	4.20	0.13	-	-	99.62
8.p5.plag	54.29	0.03	29.09	0.15	-	0.01	11.51	-	-	5.12	0.14	-	-	100.35
8.p5.plag	53.64	0.03	29.86	0.15	-	0.01	12.17	-	-	4.50	0.24	-	-	100.60
8.p5.plag	54.80	0.03	28.32	0.25	0.01	-	11.11	-	0.07	5.29	0.15	-	-	100.04
8.p5.plag	53.10	0.02	29.34	0.15	-	0.01	12.35	-	0.02	4.55	0.12	-	-	99.66
8.p5.plag	55.03	0.01	28.99	0.49	0.01	0.10	11.09	-	0.01	5.05	0.23	0.00	-	101.01
8.p6.plag	50.63	0.02	29.81	1.21	0.00	0.78	13.50	-	-	3.25	0.18	-	-	99.39
8.p6.plag	7.69	0.02	9.55	0.14	0.01	0.00	5.53	-	0.05	2.01	0.08	-	-	25.07
8.p6.plag	51.62	0.04	27.89	0.97	0.06	1.50	11.31	-	0.02	4.27	0.21	-	-	97.89
8.p6.plag	51.51	0.01	30.35	0.21	0.00	0.01	13.70	-	-	3.64	0.20	0.00	-	99.62
8.p6.plag	50.23	0.02	29.88	0.11	-	0.00	14.17	-	0.01	3.56	0.21	0.00	-	98.20
8.p6.plag	51.49	0.03	30.82	0.17	-	0.01	13.74	-	-	3.74	0.21	-	-	100.24
8.p6.plag	51.38	0.02	30.70	0.13	-	0.01	13.83	-	-	3.62	0.21	-	-	99.89
8.p6.plag	7.15	0.01	8.76	0.11	-	0.00	5.24	-	0.01	2.07	0.11	-	-	23.45
8.p7.plag	50.99	0.01	31.11	0.22	-	0.01	14.19	-	0.04	3.42	0.12	-	-	100.12
8.p7.plag	51.33	0.01	30.77	0.29	-	0.03	13.95	-	-	3.45	0.16	-	-	100.01
8.p7.plag	50.09	0.02	30.60	0.42	0.01	0.15	14.24	0.00	0.02	3.33	0.10	0.00	-	98.99
8.p7.plag	50.70	0.02	30.12	0.18	-	0.00	13.82	-	0.05	3.62	0.20	-	-	98.72
8.p7.plag	50.94	0.02	30.82	0.22	0.02	0.01	14.08	-	0.08	3.57	0.16	-	-	99.92
8.p7.plag	49.10	0.01	29.31	3.73	0.16	0.68	12.60	-	0.02	3.35	0.16	0.00	-	99.13
8.p7.plag	50.96	0.01	30.03	0.83	0.02	0.18	13.68	-	0.04	3.47	0.25	-	-	99.46
8.p7.plag	51.55	0.02	31.02	0.15	0.00	0.01	13.76	-	-	3.70	0.19	-	-	100.41
8.p7.plag	51.19	0.03	30.69	0.21	0.02	0.03	14.14	-	0.07	3.55	0.12	0.00	-	100.05
8.p7.plag	50.87	0.02	30.57	0.33	-	0.03	14.32	-	0.01	3.48	0.14	-	-	99.77
10.3.p1.plag	51.44	0.04	30.89	0.20	-	0.00	13.27	-	0.01	3.80	0.24	0.00	-	99.89
10.3.p1.plag	53.38	0.04	29.78	0.24	0.02	0.00	12.01	-	0.02	4.66	0.21	-	-	100.37
10.3.p1.plag	52.36	0.03	30.19	0.18	0.00	0.01	12.32	-	-	4.27	0.30	-	-	99.66
10.3.p1.plag	50.46	0.03	29.23	2.58	0.07	0.55	11.68	-	-	4.12	0.26	0.00	-	98.99
10.3.p1.plag	50.05	0.04	31.97	0.18	-	0.00	14.39	0.04	0.05	3.26	0.20	0.00	-	100.17
10.3.p2.plag	49.59	0.01	25.85	4.62	1.21	3.00	7.95	0.02	0.01	4.48	0.24	0.00	-	96.97
10.3.p2.plag	51.94	0.03	30.46	0.25	0.00	0.05	12.71	-	-	4.12	0.22	-	-	99.78
10.3.p2.plag	54.71	0.04	28.63	0.17	0.02	0.01	10.64	-	0.04	5.46	0.32	0.00	-	100.04
10.3.p2.plag	51.68	0.05	31.04	0.22	0.03	-	13.49	-	-	3.89	0.21	-	-	100.60
10.3.p2.plag	6.10	0.02	7.60	0.50	0.11	0.14	4.93	-	-	1.86	0.10	-	-	21.35
10.3.p2.plag	5.69	0.04	7.32	4.27	0.12	0.47	3.63	-	0.00	1.92	0.10	-	-	23.54
10.3.p2.plag	52.55	0.04	30.64	0.20	-	0.01	13.05	-	0.04	4.02	0.21	-	-	100.77
10.3.p2.plag	53.87	0.03	29.80	0.30	-	0.02	11.97	-	0.06	4.71	0.26	-	-	101.01
10.3.p3.plag	51.42	0.05	30.56	1.33	0.03	0.07	12.47	-	0.07	4.13	0.05	-	-	100.18
10.3.p3.plag	52.11	0.03	29.90	1.26	0.28	0.41	11.79	-	0.02	4.26	0.08	-	-	100.14
10.3.p3.plag	51.73	0.02	30.75	0.51	-	0.14	13.01	-	0.12	4.10	0.05	-	-	100.43
10.3.p3.plag	50.93	0.02	29.92	2.25	0.04	0.42	12.16	-	0.01	3.88	0.06	0.00	-	99.70
10.3.p3.plag	45.42	0.03	24.86	6.81	2.38	0.59	13.75	-	-	3.30	0.08	-	-	97.22
10.3.p3.plag	51.29	0.02	31.29	0.23	0.00	-	13.52	-	0.05	3.75	0.11	-	-	100.26
10.3.p3.plag	51.63	0.05	31.10	0.27	-	0.02	13.08	-	0.07	4.13	0.04	-	-	100.37
10.3.p3.plag	49.49	0.00	32.95	0.26	-	0.01	15.18	0.00	0.04	2.79	0.03	-	-	100.75
10.3.p3.plag	47.56	0.01	34.05	0.23	0.00	-	16.59	-	0.05	2.03	0.03	-	-	100.55
10.3.p4.plag	51.29	0.03	31.35	0.18	0.00	0.01	13.45	-	0.04	3.79	0.11	-	-	100.25
10.3.p4.plag	51.80	0.04	31.15	0.17	0.01	0.01	13.39	-	-	3.84	0.16	-	-	100.56
10.3.p4.plag	52.01	0.03	30.92	0.15	0.00	0.00	13.25	-	0.00	3.94	0.18	0.00	-	100.48
10.3.p4.plag	51.91	0.02	30.64	0.19	-	0.01	12.90	-	0.01	4.09	0.18	0.00	-	99.95
10.3.p4.plag	37.48	0.02	21.55	8.13	1.26	11.05	7.76	-	-	1.18	0.05	-	-	88.49
10.3.p4.plag	54.85	0.02	29.14	0.60	0.09	0.01	10.98	0.04	0.06	5.23	0.08	0.00	-	101.09
10.3.p4.plag	51.75	0.04	29.68	2.02	0.10	0.41	11.94	-	0.05	4.16	0.16	-	-	100.29
10.3.p5.plag	50.11	0.03	32.20	0.11	-	-	14.54	-	0.02	3.15	0.07	-	-	100.24
10.3.p5.plag	51.21	0.03	31.42	0.15	-	0.00	13.92	-	-	3.60	0.06	-	-	100.40
10.3.p5.plag	50.03	0.02	31.58	0.41	0.02	0.08	14.34	-	0.07	3.18	0.06	-	-	99.79
10.3.p5.plag	54.07	0.02	29.59	0.21	-	-	11.75	-	0.14	5.00	0.11	-	-	100.89
10.3.p5.plag	45.38	0.03	29.44	2.30	1.33	4.86	11.03	-	-	2.51	0.06	-	-	96.93
10.3.p5.plag	51.27	0.02	31.43	0.15	0.00	0.01	13.88	-	0.07	3.65	0.07	-	-	100.55
10.3.p6.plag	53.55	0.04	29.36	0.32	0.02	0.02	11.75	-	0.08	4.59	0.17	-	-	99.90
10.3.p6.plag	54.80	0.03	28.07	0.50	0.03	0.42	10.37	-	0.08	5.27	0.21	-	-	99.78
10.3.p6.plag	54.58	0.02	28.39	0.47	0.04	0.15	10.73	-	0.09	5.28	0.20	-	-	99.96
10.3.p6.plag	53.63	0.04	29.43	0.15	-	0.01	12.04	-	-	4.61	0.15	-	-	100.06
10.3.p6.plag	52.46	0.05	29.97	0.15	0.01	-	12.71	0.02	0.06	4.28	0.16	-	-	99.87
10.3.p6.plag	55.12	0.05	28.66	0.17	-	-	10.94	-	0.02	5.23				

7.2.p2.plag	6.76	0.01	9.00	0.10	-	0.00	5.12	-	0.01	2.15	0.04	-	-	23.19
7.2.p2.plag	50.31	0.01	30.48	0.15	0.02	0.00	13.83	-	0.01	3.58	0.02	0.00	-	98.42
7.2.p2.plag	50.43	0.02	31.30	0.25	-	-	13.87	-	0.00	3.47	0.02	-	-	99.37
7.2.p2.plag	50.78	0.02	30.02	0.16	0.02	0.01	13.21	-	0.01	3.92	0.03	-	-	98.18
7.2.p2.plag	50.63	0.02	30.31	0.15	-	-	13.49	-	0.00	3.76	0.03	-	-	98.41
7.2.p2.plag	51.02	0.02	30.15	0.22	0.02	0.29	12.92	-	0.01	3.94	0.05	0.00	-	98.63
7.2.p2.plag	44.72	0.01	29.57	0.53	0.08	0.02	16.63	-	0.05	3.03	0.18	-	-	94.83
7.2.p2.plag	49.94	0.03	30.29	0.16	0.01	0.01	13.61	-	0.07	3.61	0.05	-	-	97.77
7.2.p3.plag	0.14	-	0.10	0.14	0.05	0.20	57.23	-	-	0.01	0.01	0.00	-	57.87
7.2.p3.plag	38.16	4.55	14.97	2.67	0.02	21.00	0.06	-	0.29	0.48	8.87	-	-	91.07
7.2.p3.plag	48.77	0.02	30.46	0.12	0.02	0.01	14.19	-	0.01	3.37	0.03	0.00	-	97.00
7.2.p3.plag	37.45	4.55	14.53	2.60	-	21.31	0.02	-	0.23	0.39	8.98	0.00	-	90.05
7.2.p3.plag	0.03	0.79	16.72	25.71	0.32	7.65	0.16	0.02	-	0.02	0.03	0.00	-	51.47
7.2.p3.plag	49.53	0.05	31.47	0.18	0.02	-	14.61	0.02	-	3.25	0.03	-	-	99.15
7.2.p3.plag	50.35	0.03	30.49	0.18	0.00	0.00	13.74	-	0.01	3.75	0.02	-	-	98.57
7.2.p3.plag	-	0.83	17.10	26.37	0.25	8.39	-	0.03	0.04	0.01	0.01	-	-	53.03
7.2.p3.plag	-	0.80	16.97	26.05	0.29	8.20	0.00	0.00	-	0.02	0.01	-	-	52.36
7.2.p3.plag	49.44	0.03	30.18	0.27	0.04	0.09	11.51	-	0.01	3.49	1.19	0.00	-	96.26
7.2.p4.plag	48.50	0.02	30.09	0.15	0.01	-	14.31	-	0.08	3.38	0.01	-	-	96.53
7.2.p4.plag	48.69	0.02	29.51	0.18	0.03	-	13.73	0.00	0.05	3.75	0.04	-	-	96.00
7.2.p4.plag	49.55	0.03	30.68	0.53	0.01	0.50	14.12	-	-	3.24	0.03	-	-	98.67
7.2.p4.plag	49.70	0.01	31.08	0.20	-	0.01	14.18	-	0.05	3.51	0.04	0.00	-	98.76
7.2.p4.plag	49.05	0.02	31.04	0.18	0.01	-	14.51	-	-	3.46	0.03	-	-	98.30
7.2.p4.plag	48.62	0.02	28.72	0.72	-	1.23	13.43	-	0.09	3.44	0.03	0.00	-	96.30
7.2.p4.plag	49.38	0.02	30.80	0.37	-	0.03	14.74	-	0.01	3.42	0.03	0.00	-	98.79
7.2.p4.plag	49.60	0.01	31.46	0.38	0.01	0.01	14.49	-	0.01	3.17	0.02	0.00	-	99.17
7.2.p5.plag	48.98	0.01	31.76	0.28	0.00	0.08	14.81	-	-	3.09	0.05	-	-	99.06
7.2.p5.plag	49.86	0.02	31.03	0.19	0.04	-	14.15	-	0.11	3.52	0.04	-	-	98.96
7.2.p5.plag	51.14	0.03	30.96	0.17	0.01	-	13.56	-	0.02	3.89	0.01	-	-	99.80
7.2.p5.plag	51.08	0.01	31.73	0.27	0.01	-	14.03	-	0.02	3.52	0.03	-	-	100.70
7.2.p5.plag	50.00	0.03	31.18	0.22	0.02	0.00	14.05	-	-	3.54	0.02	0.00	-	99.06
7.2.p5.plag	49.70	0.02	31.24	0.21	-	0.01	14.42	-	-	3.40	0.02	0.00	-	99.02
7.2.p5.plag	49.95	0.01	31.78	0.24	0.01	0.07	14.40	-	-	3.35	0.03	-	-	99.83
7.2.p5.plag	48.94	0.03	32.87	0.24	0.00	0.01	15.51	-	0.05	2.71	0.02	-	-	100.39
7.2.p5.plag	9.20	0.64	19.10	22.09	0.30	7.32	1.75	-	0.04	0.37	0.04	0.00	-	60.85
7.2.p5.plag	49.26	0.02	32.19	0.20	0.00	-	15.04	-	-	2.98	0.02	0.00	-	99.71
7.2.p6.plag	50.27	0.03	29.62	0.96	0.01	1.43	13.29	-	-	3.35	0.03	-	-	99.01
7.2.p6.plag	28.89	0.07	11.03	10.03	0.14	19.26	2.25	-	-	0.18	0.03	-	-	71.87
7.2.p6.plag	49.57	0.02	31.53	0.13	-	-	14.70	-	0.00	3.24	0.04	0.00	-	99.23
7.2.p6.plag	48.79	0.03	29.02	0.35	0.04	0.40	14.24	-	0.06	3.54	0.88	0.00	-	97.35
7.2.p6.plag	50.03	0.02	31.46	0.22	0.01	-	14.38	-	0.02	3.54	0.03	0.00	-	99.72
7.2.p6.plag	50.83	0.01	31.56	0.14	-	-	14.05	-	0.00	3.67	0.03	-	-	100.28
7.2.p6.plag	50.04	0.02	31.55	0.23	0.00	-	14.58	-	0.04	3.37	0.03	0.00	-	99.86
7.2.p6.plag	51.25	0.02	31.04	0.26	0.02	0.00	13.61	-	0.02	3.74	0.03	0.00	-	100.00
7.2.p6.plag	49.81	0.03	32.22	0.34	0.00	0.00	14.85	0.03	-	3.10	0.01	0.00	-	100.41
7.2.p7.plag	50.74	0.01	31.41	0.16	0.01	0.00	13.80	-	0.04	3.60	0.06	0.00	-	99.82
7.2.p7.plag	49.83	0.02	30.24	0.13	0.01	0.01	13.88	-	-	3.89	0.15	-	-	98.15
7.2.p7.plag	45.33	0.02	27.12	3.37	0.02	9.75	9.26	-	0.01	1.99	0.04	-	-	96.92
7.2.p7.plag	49.86	0.02	31.10	0.11	0.01	0.01	14.10	-	-	3.68	0.06	-	-	98.95
7.2.p7.plag	50.34	0.03	31.55	0.12	0.00	0.00	14.31	-	0.03	3.52	0.04	-	-	99.95
7.2.p7.plag	49.39	0.02	30.05	0.17	-	-	13.82	-	0.03	3.86	0.05	-	-	97.39
7.2.p7.plag	23.79	0.18	18.40	12.31	0.35	18.26	0.32	-	0.07	0.05	0.02	0.00	-	73.74
7.2.p7.plag	51.14	0.02	30.99	0.09	0.01	0.01	13.62	-	0.06	3.86	0.06	-	-	99.86
7.2.p7.plag	51.47	0.02	31.97	0.19	-	-	13.94	-	0.11	3.49	0.03	-	-	101.22
7.2.p7.plag	52.22	0.02	30.99	0.15	0.01	0.01	12.73	-	-	4.06	0.28	0.00	-	100.48
7.2.p7.plag	51.02	0.03	31.03	0.10	-	0.01	13.72	-	0.01	3.76	0.07	-	-	99.75
7.2.p8.plag	50.87	0.01	31.73	0.15	0.00	0.00	13.99	-	0.05	3.45	0.03	-	-	100.26
7.2.p8.plag	50.75	0.02	31.31	0.12	0.01	0.01	13.96	0.02	0.00	3.69	0.04	-	-	99.94
7.2.p8.plag	50.67	0.02	31.38	0.16	0.01	-	13.93	-	-	3.54	0.03	-	-	99.73
7.2.p8.plag	49.29	0.02	30.54	0.24	0.01	0.30	13.89	-	-	3.24	0.05	-	-	97.58
7.2.p8.plag	51.15	0.01	31.53	0.10	0.02	-	13.83	-	-	3.67	0.03	-	-	100.33
7.2.p8.plag	51.27	0.02	31.59	0.10	-	-	13.63	-	0.01	3.71	0.02	0.00	-	100.35
7.2.p8.plag	49.70	0.01	31.15	0.09	-	0.01	14.19	-	0.02	3.55	0.02	0.00	-	98.75
7.2.p8.plag	49.29	0.02	31.00	0.09	-	0.00	14.04	-	0.04	3.70	0.03	-	-	98.22
7.2.p8.plag	51.41	0.01	31.33	0.13	-	0.00	13.56	-	-	3.59	0.03	0.00	-	100.06
7.2.p8.plag	51.12	0.03	30.48	0.29	-	0.18	12.52	-	0.01	4.00	0.16	-	-	98.78
7.2.p8.plag	51.84	0.02	30.83	0.14	0.01	-	13.19	-	0.00	4.06	0.04	-	-	100.12
7.2.p9.plag	52.47	0.02	29.24	0.20	0.00	0.01	12.01	0.11	0.04	3.84	0.22	-	-	98.17
7.2.p9.plag	51.36	0.03	29.45	0.19	0.01	0.00	12.57	-	-	4.18	0.08	-	-	97.88
7.2.p9.plag	38.42	4.25	14.83	3.13	0.03	21.19	0.01	-	0.02	0.62	8.94	-	-	91.45
7.2.p9.plag	36.24	2.55	15.64	7.56	0.05	21.69	0.09	-	0.14	0.26	6.29	-	-	90.51
7.2.p9.plag	39.10	4.55	15.03	3.24	0.02	21.25	0.01	-	0.11	0.72	8.74	-	-	92.76
7.2.p9.plag	51.04	0.02	30.93	0.12	0.01	-	13.49	-	-	3.76	0.13	-	-	99.50
7.2.p9.plag	51.02	0.03	26.30	0.08	0.01	-	11.35	0.61	-	2.61	0.31	-	-	92.32
7.2.p9.plag	50.86	0.03	30.68	0.14	0.00	-	13.30	-	0.00	3.67	0.15	-	-	98.82
7.2.p9.plag	36.55	3.86	14.61	8.89	0.10	19.15	0.15	-	0.11	0.27	7.30	0.00	-	91.01
7.2.p10.plag	38.33	4.76	14.79	3.10	0.01	21.48	0.02	-	0.19	0.94	8.28	-	-	91.90
7.2.p10.plag	38.52	4.64	15.19	3.24	-	21.48	0.00	-	0.18	1.06	8.28	-	-	92.59
7.2.p10.plag	38.29	4.71	15.04	5.12	0.04	20.17	0.03	-	0.21	0.75	8.31	-	-	92.66
7.2.p10.plag	38.49	4.42	15.30	3.50	0.04	21.93	0.03	-	0.17	0.79	8.43	0.00	-	93.09
7.2.p10.plag	38.62	4.81	15.07	3.17	0.01	21.44	0.02	-	0.18	0.90	8.48	-	-	92.70
7.2.p10.plag	38.65	4.68	14.82	3.11	0.02	21.40	0.04	-	0.16	0.89	8.57	-	-	92.33
7.2.p10.plag	38.74	4.63	14.80	3.40	0.01	21.39	0.03	-	0.16	0.88	8.35	0.00	-	92.40
7.2.p10.plag	46.04	1.13	8.51	4.17	0.06	17.99	12.37	-	0.00	1.87	0.45	-	-	92.58
9.4.p1.plag	49.74	0.02	31.32	0.48	0.03	0.43	13.58	-	0.02	3.42	0.05	-	-	99.09
9.4.p1.plag	51.47	0.02	31.16	0.13	-	0.02	12.89	-	-	3.91	0.18	-	-	99.79
9.4.p1.plag	51.17	0.04	31.44	0.17	0.00	0.02	13.66	-	0.03	3.57	0.08	0.00	-	100.18
9.4.p1.plag	49.70	0.01	32.82	0.13	0.01	0.01	14.82	-	-	2.96	0.06	-	-	100.51
9.4.p1.plag	50.74	0.03	31.36	0.16	0.00	0.01	13.46	-	0.01	3.75	0.05	-	-	99.56
9.4.p1.plag	50.27	0.03	31.25	0.14	0.00	0.02	13.84	-	-	3.51	0.07	-	-	99.13
9.4.p1.plag	51.35	0.01	31.27	0.18	0.00	0.01	13.31	-	0.04	3.85	0.06	-	-	100.08
9.4.p1.plag	50.30	0.02	31.54	0.20	0.00	0.00	13.97	-	0.00	3.52	0.04	-	-	99.61
9.4.p1.plag	51.42													

9.4.p2.plag	-	0.87	18.61	26.36	0.27	8.82	0.05	0.07	-	0.02	0.03	-	-	55.10
9.4.p2.plag	50.76	0.00	31.39	0.24	0.00	0.00	13.60	-	0.00	3.62	0.10	-	0.00	99.71
9.4.p2.plag	50.75	0.04	30.83	0.20	0.01	0.02	13.24	-	-	3.86	0.07	0.00	-	99.01
9.4.p2.plag	51.26	0.03	30.69	0.16	0.01	0.01	13.22	-	-	3.97	0.09	-	-	99.45
9.4.p3.plag	50.34	0.02	32.32	0.71	0.05	0.41	13.08	-	0.06	2.83	1.37	-	-	101.19
9.4.p3.plag	51.06	0.02	31.20	0.18	0.02	0.01	13.43	-	0.02	3.79	0.07	-	-	99.81
9.4.p3.plag	50.12	0.02	32.11	0.72	0.06	1.05	3.14	-	0.24	1.74	7.50	-	0.00	96.71
9.4.p3.plag	50.56	0.01	31.29	0.14	0.01	0.01	13.67	-	0.06	3.66	0.06	-	-	99.48
9.4.p3.plag	50.17	0.02	31.41	0.20	0.00	0.01	13.82	-	-	3.64	0.05	0.00	-	99.33
9.4.p3.plag	50.42	0.03	31.50	0.18	0.00	0.01	13.71	-	0.01	3.60	0.07	-	-	99.54
9.4.p3.plag	50.32	0.02	31.72	0.20	-	0.01	13.93	-	-	3.55	0.05	-	-	99.80
9.4.p3.plag	50.50	0.02	31.84	0.22	-	0.00	13.91	0.01	0.08	3.52	0.04	0.00	-	100.15
9.4.p3.plag	50.59	0.03	31.97	0.32	0.06	0.07	10.17	-	0.10	3.29	2.30	-	-	98.89
9.4.p4.plag	51.93	0.03	30.26	0.17	0.02	0.01	12.71	-	-	4.25	0.08	0.00	-	99.45
9.4.p4.plag	49.62	0.02	31.15	0.53	0.03	0.43	13.84	-	0.10	3.11	0.06	-	-	98.88
9.4.p4.plag	50.79	0.02	30.81	0.22	0.00	0.13	13.31	-	-	3.74	0.05	0.00	-	99.07
9.4.p4.plag	50.49	0.02	31.62	0.26	-	0.10	13.91	-	0.07	3.47	0.04	-	-	99.99
9.4.p4.plag	51.98	0.02	30.31	0.19	0.01	0.01	12.69	-	-	4.21	0.08	-	-	99.50
9.4.p4.plag	51.77	0.03	30.30	0.18	0.01	0.03	12.87	-	-	4.11	0.05	-	-	99.34
9.4.p4.plag	51.57	0.02	30.98	0.11	-	0.01	13.21	-	0.06	3.88	0.08	-	0.00	99.93
9.4.p4.plag	50.84	0.03	31.24	0.16	-	0.02	13.50	-	-	3.79	0.08	-	-	99.65
9.4.p5.plag	53.04	0.44	2.21	3.61	0.10	16.25	22.81	-	0.03	0.43	0.01	-	-	98.93
9.4.p5.plag	53.20	0.40	2.15	3.89	0.10	16.59	22.25	-	-	0.40	0.01	-	-	98.99
9.4.p5.plag	53.32	0.39	2.10	3.79	0.11	16.47	22.68	-	-	0.43	0.02	-	-	99.30
9.4.p5.plag	52.31	0.37	2.13	3.83	0.13	18.03	19.54	-	-	0.37	0.02	-	-	96.72
9.4.p5.plag	52.82	0.41	2.17	4.07	0.10	16.51	22.21	-	-	0.41	0.03	0.00	-	98.72
p5.plag (continui	52.57	0.44	2.21	4.38	0.11	16.44	21.93	-	-	0.42	0.02	0.00	-	98.52
9.4.p6.plag	54.13	0.03	28.78	0.14	0.01	0.00	10.91	-	0.03	5.06	0.14	-	-	99.22
9.4.p6.plag	51.55	0.03	26.37	4.23	0.09	2.16	8.43	-	0.04	4.83	0.14	-	-	97.86
9.4.p6.plag	54.44	0.03	28.71	0.18	0.02	0.03	10.63	-	-	5.20	0.18	-	-	99.42
9.4.p6.plag	54.69	0.04	28.34	0.17	0.01	-	10.35	-	0.07	5.45	0.19	-	-	99.30
9.4.p6.plag	54.04	0.04	28.87	0.23	-	0.01	10.96	-	-	5.03	0.12	-	-	99.30
9.4.p6.plag	53.29	0.04	28.67	0.48	0.03	0.29	10.93	-	0.04	4.80	0.17	0.00	-	98.74
9.4.p9.plag	-	0.86	17.76	25.67	0.30	8.36	0.07	-	-	0.00	0.03	-	-	53.04
9.4.p9.plag	51.66	0.03	30.84	0.24	-	0.00	13.07	-	0.02	4.03	0.05	-	-	99.94
9.4.p9.plag	50.89	0.03	30.99	0.29	-	0.00	13.46	-	-	3.67	0.06	-	-	99.39
9.4.p9.plag	51.49	0.01	31.30	0.19	-	0.01	13.51	-	-	3.64	0.07	-	-	100.24
9.4.p9.plag	51.61	0.02	31.11	0.21	-	0.01	13.28	0.01	0.07	3.89	0.07	-	-	100.27
9.4.p9.plag	51.30	0.02	31.48	0.19	0.00	0.01	13.51	-	0.05	3.76	0.09	-	-	100.41
9.4.p9.plag	50.87	0.02	32.07	0.27	-	0.01	14.06	-	0.07	3.54	0.05	-	-	100.97
6.p7.plagiocla	51.48	0.05	31.48	0.20	0.01	0.02	13.78	-	0.04	3.46	0.29	-	-	100.806
6.p7.plagiocla	51.32	0.03	31.52	0.23	-	0.04	13.81	-	0.00	3.36	0.32	-	-	100.619
6.p7.plagiocla	51.79	0.03	31.74	0.22	-	0.04	13.58	-	-	3.54	0.31	0.00	-	101.242
6.p7.plagiocla	51.68	0.04	31.55	0.22	0.00	0.02	13.57	-	0.01	3.44	0.30	0.00	-	100.849
6.p7.plagiocla	51.84	0.03	31.57	0.17	0.02	0.03	13.48	-	0.00	3.59	0.28	-	-	101.023
6.p8.plagiocla	52.15	0.03	31.37	0.20	-	0.03	13.35	-	-	3.54	0.31	0.00	-	100.986
6.p8.plagiocla	51.98	0.03	31.34	0.20	0.01	0.02	13.39	-	0.02	3.71	0.31	-	-	101.019
6.p8.plagiocla	51.53	0.02	31.39	0.16	-	0.03	13.38	-	0.04	3.58	0.32	-	-	100.445
6.p8.plagiocla	51.68	0.04	31.38	0.17	0.00	0.04	13.37	-	0.06	3.71	0.32	-	-	100.767
6.p8.plagiocla	51.90	0.03	31.58	0.20	0.00	0.04	13.45	-	-	3.59	0.28	-	-	101.072
6.p9.plagiocla	51.57	0.02	31.58	0.18	-	0.02	13.46	-	-	3.49	0.19	-	-	100.513
6.p9.plagiocla	51.39	0.02	32.18	0.16	0.02	0.02	14.00	-	-	3.41	0.15	-	-	101.338
6.p9.plagiocla	51.29	0.03	31.92	0.17	-	0.04	13.93	-	-	3.43	0.17	-	-	100.964
6.p9.plagiocla	52.07	0.03	31.54	0.17	-	0.04	13.46	-	0.02	3.61	0.24	0.00	-	101.195
6.p9.plagiocla	52.15	0.04	31.51	0.18	0.00	0.04	13.40	-	0.07	3.73	0.23	-	-	101.349
6.p9.plagiocla	51.83	0.02	31.97	0.16	-	0.04	13.63	-	0.06	3.65	0.17	-	-	101.525
6.p9.plagiocla	51.68	0.02	31.51	0.16	0.01	0.04	13.47	-	0.09	3.63	0.18	-	-	100.806
6.p9.plagiocla	51.58	0.03	31.45	0.14	-	0.05	13.38	-	-	3.65	0.16	-	-	100.459
1.p3.plagiocla	46.77	0.02	34.79	0.14	0.02	0.01	17.26	-	-	1.66	0.02	-	-	100.699
1.p3.plagiocla	48.26	0.03	33.66	0.18	0.00	0.00	16.02	-	0.07	2.38	0.03	0.00	-	100.636
1.p3.plagiocla	47.85	0.01	34.00	0.24	0.01	0.01	16.26	-	0.07	2.11	0.04	-	-	100.603
1.p3.plagiocla	47.56	-	33.42	0.82	-	0.39	15.71	-	0.01	2.14	0.05	-	-	100.102
1.p3.plagiocla	44.80	0.01	33.85	1.47	0.05	0.44	16.75	-	-	1.34	0.03	-	-	98.7355
1.p3.plagiocla	45.26	0.75	26.93	2.04	-	6.77	14.68	-	-	1.67	0.19	-	-	98.273
1.p3.plagiocla	48.27	0.02	33.94	0.22	0.01	0.01	16.06	-	0.02	2.24	0.04	-	-	100.82
1.p3.plagiocla	47.57	-	33.42	0.16	-	0.02	16.29	-	0.03	2.14	0.03	0.00	-	99.6649
1.p3.plagiocla	48.43	0.00	33.77	0.21	0.02	0.01	15.90	-	-	2.39	0.04	-	-	100.764
oik.p2.OPX (Pl	50.11	0.03	32.50	0.17	-	0.01	14.43	3.18	0.06	-	0.00	-	0.01	100.508
oik.p2.OPX (Pl	48.80	0.01	32.41	0.19	0.01	0.01	14.86	2.93	0.06	-	-	-	0.00	99.2755
oik.p2.OPX (Pl	49.45	0.02	32.66	0.10	0.01	0.01	14.86	2.91	0.06	-	0.02	-	0.00	100.096
oik.p2.OPX (Pl	50.24	0.01	32.20	0.14	-	0.01	14.20	3.24	0.07	0.01	0.02	-	-	100.149
2.p5.plagiocla	49.87	0.02	31.79	0.24	-	0.01	14.81	-	-	3.10	0.18	-	-	100.028
2.p5.plagiocla	47.96	0.03	32.73	0.21	0.02	0.02	15.97	-	0.03	2.38	0.11	-	-	99.4638
2.p5.plagiocla	47.87	0.03	32.47	0.25	0.01	0.02	16.11	-	0.02	2.39	0.13	0.00	-	99.2929
2.p5.plagiocla	49.05	0.01	32.07	0.24	0.02	0.03	15.22	-	0.00	2.93	0.16	-	-	99.7257
2.p7.plagiocla	48.85	0.02	32.81	0.14	-	-	15.66	-	-	2.71	0.04	-	-	100.226
2.p7.plagiocla	47.36	0.02	33.35	0.14	0.03	0.01	16.47	-	-	2.31	0.03	-	0.00	99.7131
2.p7.plagiocla	47.91	0.02	33.16	0.17	-	0.01	16.07	-	0.07	2.45	0.03	0.00	-	99.8866
2.p7.plagiocla	47.92	-	33.48	0.16	0.00	0.01	16.13	-	0.04	2.25	0.11	-	-	100.11
2.p7.plagiocla	47.61	0.00	33.12	0.56	0.03	0.36	16.10	-	0.01	2.26	0.04	0.00	-	100.095
2.p7.plagiocla	48.22	0.03	33.16	0.25	-	0.00	16.17	-	-	2.47	0.01	-	-	100.311
2.p8.plagiocla	47.48	0.01	33.73	0.17	0.00	0.03	16.66	-	0.03	2.15	0.03	0.00	-	100.283
2.p8.plagiocla	47.97	0.02	33.11	0.21	0.04	0.01	16.03	-	-	2.52	0.03	-	-	99.936
2.p8.plagiocla	47.77	0.02	33.49	0.20	0.02	0.01	16.46	-	-	2.29	0.02	0.00	-	100.28
2.p8.plagiocla	48.35	0.01	32.65	0.25	-	0.05	15.67	-	-	2.72	0.03	-	-	99.7393
2.p8.plagiocla	56.08	0.13	1.46	7.31	0.16	33.74	0.42	-	0.06	0.01	0.02	0.00	-	99.3884

2.p1.plagiocla	51.82	0.01	30.06	0.18	0.01	0.01	12.21	-	-	4.44	0.15	-	-	98.8913
2.p1.plagiocla	53.15	0.04	30.20	0.14	-	0.00	12.28	-	0.08	4.53	0.15	-	-	100.569
2.p1.plagiocla	53.97	0.04	29.81	0.23	0.02	0.01	12.01	-	0.07	4.63	0.17	-	-	100.957
2.p1.plagiocla	54.01	0.02	29.63	0.19	0.00	0.01	11.97	-	0.04	4.70	0.17	-	-	100.752
2.p1.plagiocla	53.30	0.04	29.64	0.16	-	0.02	11.79	-	0.04	4.73	0.13	-	0.00	99.8635
2.p2.plagiocla	51.09	0.02	31.82	0.21	0.02	0.01	14.17	-	-	3.34	0.13	-	-	100.831
2.p2.plagiocla	50.58	0.02	32.10	0.13	-	0.01	14.46	-	-	3.15	0.11	-	-	100.564
2.p2.plagiocla	50.71	0.01	32.09	0.16	0.02	0.00	14.52	-	-	3.22	0.15	-	-	100.89
2.p2.plagiocla	50.61	0.02	32.38	0.16	0.02	-	14.66	-	0.01	3.15	0.13	0.00	-	101.133
2.p2.plagiocla	49.83	0.02	32.75	0.22	-	0.01	15.28	-	0.00	2.80	0.10	-	-	101.007
2.p3.plagiocla	51.44	0.02	31.87	0.21	0.01	0.01	14.05	-	0.03	3.37	0.24	0.00	-	101.235
2.p3.plagiocla	51.57	0.01	31.39	0.16	-	0.02	13.68	-	-	3.58	0.23	-	-	100.645
2.p3.plagiocla	50.06	0.01	32.77	0.14	-	0.01	15.17	-	-	2.72	0.15	-	-	101.024
2.p3.plagiocla	51.38	0.04	31.75	0.20	0.01	0.01	13.99	-	0.02	3.44	0.21	0.00	-	101.053
2.p3.plagiocla	49.92	0.03	31.61	0.61	0.03	1.09	14.01	-	0.04	2.96	0.18	-	-	100.49
2.p4.plagiocla	49.59	0.02	32.15	0.13	0.01	0.01	14.41	-	0.10	3.04	0.13	-	-	99.5953
2.p4.plagiocla	50.20	0.00	32.22	0.28	0.01	0.07	14.41	-	0.04	3.04	0.18	0.00	-	100.451
2.p4.plagiocla	51.75	0.01	30.82	0.22	-	0.10	13.32	-	0.09	3.71	0.14	-	0.00	100.173
2.p5.plagiocla	50.47	0.03	31.64	0.16	-	0.01	13.97	-	0.02	3.45	0.19	-	-	99.9302
2.p5.plagiocla	51.40	0.01	31.87	0.15	0.01	0.00	13.86	-	0.07	3.40	0.15	-	-	100.926
2.p5.plagiocla	51.69	0.03	31.28	0.20	-	0.00	13.49	-	0.09	3.64	0.17	-	-	100.593
2.p5.plagiocla	51.10	0.02	31.87	0.40	-	0.07	13.98	-	0.07	3.50	0.16	-	-	101.166
2.p5.plagiocla	50.60	0.02	31.61	0.17	0.00	0.02	14.00	-	0.03	3.45	0.17	-	-	100.079
2.p6.plagiocla	50.90	0.02	32.23	0.16	0.00	0.02	14.25	-	-	3.26	0.17	0.00	-	101.003
2.p6.plagiocla	48.93	0.02	32.97	0.32	-	0.10	15.39	-	0.04	2.57	0.11	-	-	100.44
2.p6.plagiocla	49.12	0.01	33.22	0.17	0.00	0.02	15.52	-	0.06	2.63	0.08	-	-	100.835
2.p6.plagiocla	50.28	0.00	32.18	0.14	-	0.02	14.59	-	0.04	3.07	0.14	-	-	100.464
2.p6.plagiocla	50.67	0.02	31.85	0.20	0.01	0.04	14.30	-	0.03	3.33	0.18	-	0.00	100.628

Table A7. Electron probe microanalysis for spot analyses on orthopyroxene.

SAMPLE	SiO2	TiO2	ZnO	Al2O3	V2O3	Cr2O3	FeO	NiO	MnO	MgO	CaO	Na2O	K2O	O	H2O	TOTAL
8.p1.opx	55.59	0.11	0.03	1.41	0.00	0.25	10.84	0.11	0.27	30.11	1.18	0.01	0.01	0.00	-	99.93
8.p1.opx	55.74	0.14	0.00	1.31	0.01	0.26	10.73	0.11	0.24	30.17	1.32	0.01	0.01	0.00	-	100.05
8.p1.opx	54.92	0.14	0.02	1.11	-	0.05	10.71	0.10	0.22	29.99	0.97	0.00	0.02	-	-	98.26
8.p1.opx	55.27	0.14	-	1.30	0.03	0.18	10.30	0.09	0.24	29.78	1.54	0.03	0.01	0.00	-	98.90
8.p1.opx	55.52	0.11	-	1.06	0.00	0.18	10.65	0.11	0.23	30.79	0.84	-	0.01	-	-	99.51
8.p2.opx	55.94	0.14	-	1.33	0.02	0.31	11.11	0.09	0.23	29.95	1.87	0.02	0.02	-	-	101.01
8.p2.opx	55.86	0.12	0.01	1.30	0.01	0.19	10.65	0.09	0.20	30.31	0.81	0.00	0.04	-	-	99.59
8.p2.opx	55.77	0.11	-	1.16	0.00	0.22	10.54	0.07	0.24	30.58	0.88	0.01	0.01	-	-	99.59
8.p2.opx	55.96	0.12	0.04	1.25	0.02	0.25	10.34	0.10	0.25	29.97	1.60	0.01	0.03	0.00	-	99.94
8.p2.opx	55.81	0.09	0.04	0.97	0.02	0.27	10.68	0.10	0.25	30.98	0.86	-	0.01	-	-	100.09
8.p3.opx	56.18	0.13	-	1.22	0.02	0.18	10.88	0.08	0.22	30.27	1.36	0.03	0.01	0.00	-	100.58
8.p3.opx	55.99	0.14	0.02	1.30	0.02	0.24	10.67	0.09	0.25	30.47	1.50	0.02	0.01	0.00	-	100.71
8.p3.opx	56.29	0.11	-	1.32	-	0.20	10.32	0.10	0.22	30.22	1.68	0.03	0.01	0.00	-	100.50
8.p3.opx	55.94	0.12	0.00	1.24	-	0.26	10.60	0.11	0.25	30.53	0.75	0.02	0.02	-	-	99.84
8.p3.opx	56.82	0.11	-	1.40	0.01	0.40	10.74	0.10	0.23	29.34	1.64	0.02	0.02	-	-	100.81
8.p3.opx	55.59	0.11	-	1.37	0.01	0.22	11.10	0.10	0.23	29.87	1.60	0.02	0.02	-	-	100.24
8.p4.opx	55.60	0.12	0.01	1.16	0.00	0.21	10.66	0.10	0.20	30.97	1.13	0.02	0.02	-	-	100.19
8.p4.opx	55.95	0.13	0.00	1.39	-	0.21	10.12	0.09	0.21	29.98	1.11	-	0.01	-	-	99.19
8.p4.opx	55.64	0.12	-	1.29	0.01	0.23	10.63	0.09	0.18	30.30	1.45	0.03	0.02	-	-	99.98
8.p4.opx	52.62	0.09	0.00	1.39	0.00	0.18	7.15	0.06	0.18	24.46	6.72	0.09	0.04	-	-	92.98
8.p4.opx	56.26	0.13	0.01	1.08	0.02	0.22	10.29	0.09	0.24	31.15	0.99	0.01	0.01	0.00	-	100.50
8.p5.opx	56.46	0.14	0.00	1.32	0.02	0.18	10.28	0.10	0.24	30.52	1.29	0.02	0.03	0.00	-	100.60
8.p5.opx	55.91	0.13	-	1.45	0.05	0.14	10.60	0.10	0.24	29.63	1.79	0.01	0.02	-	-	100.08
8.p5.opx	56.24	0.14	0.01	1.35	0.02	0.19	10.56	0.09	0.23	30.32	1.34	0.02	0.01	0.00	-	100.52
8.p5.opx	56.14	0.13	-	1.35	0.03	0.25	10.46	0.08	0.22	30.13	1.40	0.02	0.02	-	-	100.22
8.p5.opx	55.43	0.13	-	1.48	0.02	0.21	10.52	0.10	0.26	30.06	1.85	0.03	0.01	-	-	100.09
8.p6.opx	55.93	0.13	-	1.57	-	0.33	10.73	0.09	0.25	29.80	1.33	0.02	0.02	-	-	100.20
8.p6.opx	56.06	0.12	-	1.42	0.02	0.24	10.36	0.11	0.23	28.80	2.38	0.04	0.02	-	-	99.80
8.p6.opx	8.01	0.06	-	0.32	0.01	0.06	7.17	0.08	0.17	9.75	0.32	0.02	0.01	-	-	26.00
8.p6.opx	55.08	0.14	-	1.70	-	0.25	7.26	0.09	0.16	25.16	6.13	0.13	0.03	0.00	-	96.14
8.p6.opx	55.30	0.14	-	1.51	0.01	0.26	9.75	0.11	0.23	28.16	4.36	0.07	0.02	-	-	99.93
8.p7.opx	56.32	0.13	-	1.35	0.01	0.31	10.34	0.11	0.24	30.42	1.72	0.02	0.02	0.00	-	100.99
8.p7.opx	56.38	0.11	-	1.23	0.01	0.22	10.09	0.09	0.28	30.53	1.07	-	0.02	0.00	-	100.02
8.p7.opx	56.49	0.11	-	1.28	0.02	0.26	10.28	0.12	0.25	30.61	1.24	0.01	0.02	-	-	100.71
8.p7.opx	55.88	0.12	-	1.22	-	0.20	9.67	0.09	0.25	31.33	0.76	-	0.01	-	-	99.53
8.p7.opx	56.45	0.11	0.02	1.36	-	0.24	9.88	0.09	0.26	30.11	1.90	0.02	0.01	-	-	100.45
10.3.p2.opx	54.77	0.18	0.03	1.68	0.03	0.24	11.61	0.09	0.26	28.38	2.07	0.05	0.01	-	-	99.40
10.3.p2.opx	54.58	0.19	0.00	1.64	0.02	0.26	11.68	0.06	0.23	28.63	1.83	0.03	0.01	-	-	99.17
10.3.p2.opx	55.32	0.19	0.02	1.59	0.01	0.28	11.77	0.09	0.27	28.55	1.87	0.03	0.02	0.00	-	99.99
10.3.p2.opx	38.04	3.82	0.00	15.32	0.06	0.26	5.95	0.14	0.00	20.71	0.00	0.28	9.84	-	-	94.44
10.3.p2.opx	55.14	0.14	-	1.57	0.01	0.10	11.91	0.08	0.25	29.42	0.82	0.03	0.03	0.00	-	99.50
10.3.p2.opx	55.20	0.18	0.01	1.57	0.02	0.18	11.64	0.10	0.25	28.47	2.27	0.06	0.02	0.00	-	99.97
10.3.p4.opx	6.51	0.14	-	0.45	0.04	0.07	5.12	0.04	0.13	6.25	3.51	0.18	0.02	-	-	22.46
10.3.p4.opx	55.40	0.21	0.03	1.38	0.02	0.16	11.82	0.07	0.25	29.24	1.16	0.03	0.02	-	-	99.80
10.3.p4.opx	55.24	0.17	0.02	1.41	0.01	0.11	11.53	0.08	0.25	29.21	0.86	0.02	0.03	0.00	-	98.96
10.3.p4.opx	56.55	0.13	-	1.24	0.03	0.32	11.11	0.07	0.26	30.31	0.62	-	0.01	-	-	100.65
10.3.p4.opx	55.46	0.17	0.02	1.42	0.03	0.20	11.88	0.08	0.24	29.04	1.49	0.01	0.01	-	-	100.05
10.3.p5.opx	7.42	0.07	0.01	0.39	0.01	0.02	6.54	0.05	0.15	9.21	0.35	0.00	0.02	-	-	24.24
10.3.p5.opx	56.26	0.14	0.02	1.38	0.01	0.26	10.12	0.08	0.24	30.66	0.90	0.04	0.03	-	-	100.12
10.3.p5.opx	55.86	0.15	0.00	1.41	0.01	0.23	10.45	0.07	0.24	30.22	1.16	0.00	0.01	0.00	-	99.79
10.3.p5.opx	55.72	0.14	-	1.47	0.02	0.33	10.55	0.07	0.22	29.88	1.51	0.03	0.01	-	-	99.96
10.3.p5.opx	56.37	0.17	-	1.42	-	0.19	10.09	0.08	0.25	31.01	0.84	0.02	0.02	0.00	-	100.46
10.3.p5.opx	56.15	0.16	-	1.33	-	0.08	9.98	0.08	0.25	30.88	0.91	0.00	0.01	0.00	-	99.83
10.3.p6.opx	55.00	0.26	0.01	1.37	0.03	0.29	11.47	0.08	0.28	28.54	1.82	0.04	0.02	-	-	99.21
10.3.p6.opx	55.69	0.27	-	1.35	0.02	0.12	12.05	0.09	0.29	29.42	1.01	0.00	0.03	0.00	-	100.33
10.3.p6.opx	55.43	0.22	-	1.41	0.02	0.15	11.55	0.09	0.25	29.09	1.54	0.02	0.03	-	-	99.79
10.3.p6.opx	55.44	0.22	0.02	1.28	0.02	0.20	11.79	0.08	0.24	28.87	1.53	-	0.01	-	-	99.70
10.3.p6.opx	55.85	0.19	0.02	1.28	0.01	0.13	11.68	0.07	0.23	29.47	0.88	-	0.01	-	-	99.83
7.2.p7.opx	56.48	0.11	-	1.62	0.02	0.21	8.77	0.07	0.19	30.06	2.24	0.02	0.01	0.00	-	99.80
7.2.p7.opx	56.22	0.12	0.01	1.59	0.01	0.27	8.79	0.08	0.17	30.30	1.65	-	0.02	-	-	99.24
7.2.p7.opx	56.91	0.11	-	1.51	-	0.23	7.37	0.10	0.20	32.05	0.76	0.00	0.03	-	-	99.26
7.2.p7.opx	56.99	0.11	-	2.04	-	0.35	5.07	0.09	0.05	26.06	1.18	0.22	0.07	0.00	-	92.23
7.2.p7.opx	55.54	0.11	-	1.47	-	0.35	8.60	0.09	0.19	31.07	1.66	0.03	0.02	-	-	99.12
7.2.p9.opx	56.19	0.10	-	1.45	0.02	0.19	9.44	0.12	0.22	30.90	1.30	0.02	0.01	0.00	-	99.95
7.2.p9.opx	56.30	0.10	0.00	1.45	0.00	0.22	9.12	0.10	0.23	30.43	1.61	0.03	0.03	-	-	99.62
7.2.p9.opx	55.41	0.11	0.01	1.45	0.01	0.30	8.88	0.09	0.22	30.43	2.06	0.03	0.03	-	-	99.02
7.2.p9.opx	55.87	0.11	0.01	1.41	-	0.16	8.97	0.10	0.22	30.19	1.74	0.02	0.00	-	-	98.79
7.2.p9.opx	56.32	0.12	-	1.48	0.03	0.27	8.81	0.12	0.18	29.34	2.72	0.03	0.02	0.00	-	99.43
7.2.p10.opx	55.99	0.13	-	1.40	0.01	0.40	8.75	0.10	0.20	30.90	1.56	0.02	0.01	-	-	99.46
7.2.p10.opx	55.28	0.14	-	1.40	0.01	0.30	8.80	0.10	0.19	31.65	1.65	0.02	0.02	0.00	-	99.56
7.2.p10.opx	55.55	0.13	0.00	1.38	0.01	0.21	8.56	0.11	0.19	31.52	0.98	-	0.02	-	-	98.64
7.2.p10.opx	55.94	0.13	0.00	1.36	0.03	0.15	8.59	0.08	0.21	31.94	0.92	-	0.02	0.00	-	99.38
7.2.p10.opx	55.38	0.15	-	1.24	0.01	0.15	8.27	0.08	0.18	32.39	0.90	0.02	0.01	0.00	-	98.77
9.4.p1.opx	56.71	0.12	-	1.19	0.00	0.14	7.23	0.06	0.20	33.22	0.79	0.01	0.01	0.00	-	99.69
9.4.p1.opx	56.80	0.10	-	0.96	0.01	0.08	7.03	0.08	0.18	33.60	0.72	0.01	0.02	0.00	-	99.60
9.4.p1.opx	56.69	0.11	0.01	1.19	0.01	0.24	7.13	0.07	0.17	33.05	0.59	-	0.01	-	-	99.27
9.4.p1.opx	56.63	0.12	-	1.02	0.01	0.12	7.67	0.07	0.20	33.07	0.78	0.00	0.02	0.00	-	99.71
9.4.p1.opx	55.23	0.14	-	1.70	0.03	0.27	7.75	0.08	0.16	32.22	1.22	0.01	0.01	-	-	98.81
9.4.p1.opx	56.97	0.10	0.02	1.51	0.04	0.45	6.37	0.07	0.17	32.0						

9.4.p6.cpx	54.97	0.19	0.01	1.61	0.01	0.25	10.56	0.09	0.23	28.67	2.08	0.04	0.02	-	-	98.72
9.4.p7.cpx	55.59	0.20	-	1.53	0.01	0.11	9.55	0.09	0.24	30.44	1.32	0.06	0.02	0.00	-	99.15
9.4.p7.cpx	55.51	0.23	-	1.37	0.01	0.12	9.23	0.08	0.23	30.99	0.91	0.01	0.02	-	-	98.71
9.4.p7.cpx	55.91	0.23	-	1.34	0.04	0.32	7.90	0.06	0.22	32.61	0.75	0.01	0.01	0.00	-	99.39
9.4.p7.cpx	55.29	0.15	-	1.70	0.02	0.29	9.41	0.09	0.23	29.77	2.04	0.04	0.02	-	-	99.05
9.4.p7.cpx	55.59	0.16	-	1.55	0.04	0.27	9.25	0.09	0.22	30.31	1.76	0.03	0.02	-	-	99.30
9.4.p7.cpx	55.80	0.15	-	1.56	0.03	0.28	9.33	0.08	0.23	30.11	2.05	0.03	0.02	-	-	99.66
9.4.p8.opx	54.86	0.28	-	1.43	-	0.14	11.20	0.11	0.25	28.80	1.37	0.03	0.02	-	-	98.50
9.4.p8.opx	53.42	0.36	0.01	2.27	0.06	2.43	11.09	0.07	0.10	23.53	0.31	0.13	0.05	0.00	-	93.83
9.4.p8.opx	57.51	0.24	0.00	1.56	0.01	0.11	10.27	0.09	0.21	26.93	1.77	0.05	0.02	-	-	98.79
9.4.p8.opx	54.52	0.26	0.02	1.30	0.01	0.08	11.05	0.12	0.24	29.15	1.11	0.02	0.02	-	-	97.91
9.4.p8.opx	54.16	0.16	-	1.64	0.02	0.26	10.85	0.11	0.24	27.70	2.85	0.05	0.03	-	-	98.05
9.4.p8.opx	54.73	0.23	0.00	1.32	0.00	0.31	10.68	0.07	0.26	29.80	0.99	-	0.01	0.00	-	98.42
9.4.p8.opx	55.22	0.29	0.01	1.31	0.03	0.14	10.94	0.10	0.28	29.03	1.09	0.02	0.01	-	-	98.46
9.4.p9.opx	56.10	0.11	0.01	1.58	0.02	0.30	8.94	0.10	0.23	31.38	0.95	0.01	0.01	0.00	-	99.75
9.4.p9.opx	56.40	0.11	0.03	1.14	0.02	0.31	7.82	0.08	0.18	32.83	0.68	0.02	0.01	-	-	99.64
9.4.p9.opx	56.54	0.11	0.00	1.28	0.01	0.21	6.45	0.10	0.16	31.46	0.60	0.05	0.01	0.00	-	96.99
9.4.p9.opx	56.68	0.12	-	1.25	0.00	0.26	7.30	0.08	0.20	33.32	0.69	0.01	0.01	-	-	99.92
9.4.p9.opx	56.38	0.11	-	1.21	0.02	0.19	7.87	0.09	0.15	32.11	0.94	0.01	0.02	-	-	99.10
9.4.p9.opx	56.88	0.11	-	1.18	0.01	0.15	7.27	0.07	0.16	32.93	0.74	0.01	0.02	-	-	99.53
2.2.p2.OPX	56.54	0.13	0.02	1.25	0.02	0.36	7.37	0.07	0.19	33.60	0.57	-	0.03	-	-	100.128
2.2.p2.OPX	56.33	0.10	0.01	1.14	0.01	0.28	7.16	0.08	0.14	33.35	0.46	0.00	0.03	0.00	-	99.0755
2.2.p2.OPX	55.94	0.11	0.01	1.33	0.02	0.34	7.79	0.09	0.18	32.54	0.63	-	0.01	0.00	-	98.9866
2.2.p2.OPX	55.86	0.11	0.00	1.28	0.00	0.15	7.43	0.07	0.17	32.62	0.71	0.01	0.02	-	-	98.4321
2.2.p2.OPX	56.33	0.11	-	1.29	-	0.25	7.60	0.07	0.16	32.94	0.51	-	0.02	-	-	99.2853
2.2.p3.OPX	55.19	0.14	-	1.58	0.01	0.25	9.93	0.08	0.21	31.66	1.10	0.00	0.01	-	-	100.169
2.2.p3.OPX	55.51	0.15	-	1.58	0.00	0.23	9.44	0.09	0.23	30.22	1.81	0.00	0.02	0.00	-	99.2684
2.2.p3.OPX	55.79	0.10	-	1.60	0.01	0.43	9.64	0.08	0.22	30.36	1.18	-	0.03	0.00	-	99.4344
2.2.p3.OPX	55.60	0.11	-	1.35	0.01	0.30	9.61	0.10	0.20	31.01	0.94	-	0.01	-	-	99.2342
2.2.p3.OPX	55.54	0.12	-	1.43	0.00	0.24	9.35	0.10	0.22	30.27	2.04	0.00	0.01	-	-	99.3355
2.2.p3.CPX	53.12	0.30	-	2.38	0.04	0.66	4.03	0.04	0.12	16.33	23.19	0.34	0.01	0.00	-	100.566
2.2.p3.CPX	53.13	0.27	0.00	2.35	0.04	0.72	4.14	0.04	0.10	16.63	22.65	0.29	0.01	-	-	100.385
2.2.p3.CPX	53.01	0.23	-	2.09	0.02	0.45	3.79	0.05	0.11	16.25	23.53	0.30	0.01	0.00	-	99.8434
2.2.p3.CPX	53.36	0.21	-	1.89	0.05	0.62	3.57	0.05	0.09	16.35	23.52	0.33	0.01	-	-	100.038
2.2.p3.CPX	53.54	0.21	0.02	1.89	0.03	0.46	3.68	0.07	0.12	16.57	23.32	0.28	0.01	0.00	-	100.205
2.2.p4.OPX	56.30	0.12	-	1.29	-	0.20	9.01	0.10	0.18	31.68	1.19	0.00	0.01	-	-	100.083
2.2.p4.OPX	55.99	0.14	-	1.57	0.01	0.27	8.98	0.10	0.24	31.39	1.60	0.02	0.00	0.00	-	100.316
2.2.p4.OPX	56.43	0.12	-	1.26	0.01	0.16	7.20	0.08	0.16	33.04	0.48	0.01	0.03	-	-	98.9756
2.2.p4.OPX	57.14	0.11	-	1.31	0.01	0.22	7.28	0.07	0.16	33.66	0.49	-	0.02	0.00	-	100.485
2.2.p4.OPX	57.14	0.12	-	1.25	-	0.09	7.21	0.10	0.16	33.63	0.49	0.01	0.03	-	-	100.219
2.2.p4.OPX	56.16	0.12	0.00	1.31	0.01	0.13	8.04	0.07	0.17	32.15	0.75	0.01	0.01	0.00	-	98.9488
2.2.p5.OPX	56.10	0.11	-	1.36	0.01	0.23	9.61	0.10	0.21	32.04	0.69	-	0.02	-	-	100.469
2.2.p5.OPX	55.24	0.14	-	1.62	0.02	0.34	9.60	0.09	0.24	30.30	2.26	0.03	0.01	-	-	99.8987
2.2.p5.OPX	55.01	0.12	-	1.58	-	0.31	10.41	0.09	0.24	29.96	1.68	0.03	0.01	-	-	99.4337
2.2.p5.OPX	55.17	0.13	-	1.58	0.02	0.27	10.02	0.12	0.20	30.73	1.15	-	0.02	-	-	99.4127
2.2.p5.OPX	55.58	0.08	-	1.03	-	0.14	9.72	0.11	0.21	31.39	0.91	-	0.02	-	-	99.1935
2.2.p6.OPX	55.39	0.11	-	1.66	0.03	0.49	9.93	0.07	0.24	30.37	2.26	0.04	0.02	0.00	-	100.61
2.2.p6.OPX	55.47	0.10	0.00	1.66	0.03	0.31	9.57	0.08	0.24	31.20	1.48	0.02	0.02	-	-	100.184
2.2.p6.OPX	55.49	0.11	-	1.70	0.01	0.37	9.10	0.09	0.22	30.76	2.39	0.04	0.01	0.00	-	100.302
2.2.p6.OPX	55.69	0.12	-	1.63	0.00	0.55	8.83	0.08	0.18	31.57	2.00	0.02	0.01	-	-	100.698
2.2.p6.OPX	55.30	0.11	-	1.64	0.02	0.40	9.86	0.11	0.23	30.74	2.05	0.03	0.02	0.00	-	100.511
2.2.p6.OPX	55.39	0.11	-	1.74	0.01	0.42	9.64	0.08	0.23	30.91	1.64	0.03	0.01	-	-	100.222
1.2.p1.OPX	56.36	0.15	-	1.15	0.01	0.21	10.88	0.09	0.26	30.10	1.07	-	0.02	0.00	-	100.311
1.2.p1.OPX	55.64	0.20	-	1.11	0.02	0.28	11.63	0.10	0.24	29.54	1.12	0.02	0.02	0.00	-	99.914
1.2.p1.OPX	55.99	0.20	0.01	1.22	0.00	0.44	11.25	0.09	0.25	29.28	1.92	0.04	0.02	0.00	-	100.72
1.2.p1.OPX	55.85	0.23	-	1.20	-	0.27	11.90	0.08	0.25	30.02	0.99	0.01	0.02	0.00	-	100.813
1.2.p1.OPX	55.80	0.22	0.01	1.04	0.02	0.10	11.68	0.07	0.27	29.63	1.19	0.02	0.03	0.00	-	100.063
1.2.p1.CPX	54.17	0.39	-	1.63	0.02	0.71	4.22	0.05	0.11	16.38	23.13	0.33	0.02	-	-	101.166
1.2.p1.CPX	54.19	0.36	0.04	1.70	0.03	0.84	4.63	0.05	0.12	16.27	22.64	0.33	0.03	-	-	101.231
1.2.p2.CPX	53.52	0.29	-	2.29	0.05	0.67	4.24	0.03	0.12	15.84	22.91	0.39	0.01	0.00	-	100.357
1.2.p2.CPX	53.65	0.30	-	2.44	0.03	0.72	4.21	0.04	0.16	15.94	23.04	0.48	0.01	0.00	-	101.037
1.2.p2.CPX	54.35	0.29	-	2.34	0.04	0.68	4.09	0.05	0.13	15.57	23.33	0.44	0.01	-	-	101.327
1.2.p2.CPX	54.04	0.23	0.00	2.47	0.04	0.70	3.97	0.07	0.10	16.00	23.17	0.54	0.02	0.00	-	101.34
1.2.p2.CPX	53.66	0.28	-	2.11	0.05	0.68	4.24	0.05	0.13	16.28	22.60	0.39	0.02	-	-	100.488
1.2.p2.OPX	56.14	0.13	-	1.28	0.02	0.30	10.84	0.09	0.24	31.03	0.83	0.00	0.01	-	-	100.915
1.2.p2.OPX	55.96	0.14	0.00	1.33	0.02	0.45	11.09	0.09	0.20	31.13	0.84	0.02	0.02	0.00	-	101.291
1.2.p2.OPX	56.06	0.15	-	1.36	0.01	0.48	10.84	0.10	0.25	30.36	0.84	0.01	0.01	0.00	-	100.481
1.2.p2.OPX	56.45	0.13	-	1.19	0.02	0.32	10.97	0.09	0.22	30.49	1.01	-	0.01	-	-	100.897
1.2.p2.OPX	56.06	0.13	-	1.26	0.01	0.29	11.22	0.08	0.26	30.30	1.18	-	0.01	-	-	100.798
1.2.p3.OPX	56.05	0.14	-	1.30	0.01	0.39	10.67	0.09	0.27	30.26	1.76	0.03	0.01	0.00	-	100.967
1.2.p3.OPX	55.91	0.11	-	1.21	0.02	0.26	11.01	0.09	0.24	30.68	0.68	0.00	0.01	-	-	100.221
1.2.p3.OPX	56.21	0.12	-	1.14	0.01	0.10	10.91	0.08	0.23	32.01	0.73	0.00	0.01	0.00	-	101.563
1.2.p3.OPX	55.88	0.12	0.01	1.25	0.00	0.37	10.89	0.08	0.22	30.78	0.73	0.02	0.02	-	-	100.403
1.2.p3.CPX	55.43	0.11	0.01	1.26	0.01	0.26	11.40	0.10	0.25	30.81	0.58	0.00	0.02	0.00	-	100.236
1.2.p3.CPX	52.66	0.28	-	2.18	0.03	0.69	4.25	0.06	0.18	16.25	22.60	0.42	0.02	-	-	99.6341
1.2.p3.CPX	53.92	0.25	0.01	1.96	0.05	0.87	4.19	0.04	0.11	16.28	22.68	0.39	0.01	-	-	100.769
1.2.p3.CPX	55.20	0.11	-	1.44	-	0.46	10.87	0.08	0.25	29.85	0.49	0.03	0.04	0.00	-	98.8181
1.2.p4.CPX	53.65	0.32	-	2.23	0.03	0.77	3.89	0.04	0.09	16.07	23.09	0.47	0.01	0.00	-	100.68
1.2.p4.CPX	53.86	0.30	0.00	1.98	0.04	0.74	3.92	0.06	0.10	16.28	22.95	0.40	0.01	0.00	-	100.643

1.2.p5.OPX	55.18	0.15	-	1.12	0.02	0.25	11.24	0.10	0.26	31.44	0.77	-	0.01	-	-	100.528
1.2.p5.OPX	56.51	0.14	-	0.89	0.00	0.26	11.09	0.08	0.21	30.89	0.59	-	0.02	-	-	100.68
1.2.p5.OPX	56.04	0.18	-	1.21	0.03	0.16	10.75	0.09	0.25	30.67	1.19	0.00	0.02	0.00	-	100.58
1.2.p5.CPX	54.27	0.32	-	1.75	0.03	0.47	4.48	0.05	0.15	16.39	22.72	0.36	0.01	0.00	-	100.999
1.2.p5.CPX	53.41	0.35	-	1.91	0.06	0.68	4.20	0.02	0.15	16.08	22.98	0.35	0.03	0.00	-	100.212
1.2.p5.CPX	53.66	0.37	0.02	2.19	0.04	0.67	4.46	0.03	0.12	16.02	22.83	0.46	0.01	0.00	-	100.885
1.2.p5.CPX	53.47	0.38	0.01	2.21	0.04	0.80	4.44	0.06	0.13	16.17	22.94	0.38	0.02	0.00	-	101.053
1.2.p5.CPX	54.35	0.23	0.01	1.48	0.03	0.38	5.92	0.07	0.17	20.17	16.32	0.23	0.02	0.00	-	99.3781
1.2.p6.CPX	53.77	0.28	0.00	2.05	0.04	0.71	3.96	0.06	0.09	16.09	23.04	0.35	0.02	-	-	100.474
1.2.p6.CPX	53.55	0.26	0.00	2.27	0.04	0.91	4.09	0.06	0.13	15.97	23.14	0.40	0.02	-	-	100.866
1.2.p6.CPX	56.27	0.06	0.00	1.93	0.02	0.10	11.42	0.08	0.25	30.00	0.52	0.01	0.01	-	-	100.679
1.2.p6.CPX	53.41	0.25	0.01	2.31	0.03	0.86	4.00	0.04	0.10	16.33	22.99	0.44	0.02	0.00	-	100.787
1.2.p6.CPX	55.79	0.09	-	1.60	0.01	0.42	11.53	0.10	0.23	30.51	0.52	-	0.02	-	-	100.828
1.2.p6.OPX	55.70	0.13	-	1.36	0.02	0.43	11.01	0.07	0.24	29.95	1.43	0.01	0.02	0.00	-	100.364
1.2.p6.OPX	56.09	0.12	-	1.24	0.01	0.34	11.12	0.08	0.24	30.87	0.71	0.01	0.01	-	-	100.856
1.2.p6.OPX	55.33	0.12	-	1.37	0.01	0.33	10.91	0.07	0.22	30.36	1.80	0.02	0.02	-	-	100.554
1.2.p6.OPX	55.77	0.11	-	1.40	-	0.40	11.26	0.08	0.28	30.61	0.88	0.01	0.02	-	-	100.814
1.2.p6.OPX	55.99	0.10	0.00	1.51	0.02	0.36	11.18	0.09	0.29	30.32	1.26	0.02	0.02	0.00	-	101.169
1.6.p3.opx	55.69	0.14	0.01	1.44	0.02	0.34	11.45	0.07	0.25	30.15	1.46	0.01	0.01	0.00	0	101.05
1.6.p3.opx	55.18	0.18	0.00	1.33	0.00	0.29	10.44	0.08	0.25	30.92	1.24	0.01	0.02	0.00	0	99.9355
1.6.p3.opx	55.82	0.13	0.03	1.43	0.01	0.39	11.42	0.10	0.23	30.28	1.63	0.01	0.02	0.00	0	101.5
1.6.p3.opx	54.99	0.18	0.01	1.40	0.02	0.36	10.40	0.09	0.28	30.29	2.05	0.02	0.02	0.00	0	100.098
1.6.p3.opx	56.49	0.16	0.01	1.38	0.00	0.33	10.28	0.09	0.26	31.36	1.01	0.00	0.02	0.00	0	101.382
1.6.p5.opx	55.92	0.15	0.00	1.30	0.02	0.30	11.83	0.10	0.25	30.45	0.76	0.00	0.02	0.00	0	101.103
1.6.p5.opx	56.05	0.14	0.01	1.31	0.01	0.29	11.24	0.11	0.23	29.84	1.98	0.03	0.01	0.00	0	101.256
1.6.p5.opx	53.76	0.13	0.00	1.51	0.05	0.47	12.17	0.08	0.25	29.27	0.77	0.01	0.01	0.00	0	98.4643
1.6.p5.opx	56.17	0.12	0.00	1.42	0.02	0.33	11.63	0.10	0.23	29.70	1.67	0.03	0.02	0.00	0	101.434
1.6.p5.opx	55.12	0.12	0.01	1.58	0.03	0.37	12.07	0.10	0.26	29.37	1.21	0.00	0.02	0.00	0	100.264
1.6.p5.opx	54.97	0.15	0.00	1.38	0.00	0.38	11.55	0.08	0.20	30.07	1.04	0.03	0.02	0.00	0	99.8854
.1oik.p1.OP	55.52	0.12	0.01	1.45	0.04	0.32	9.24	0.09	0.18	31.50	0.83	0.01	0.03	0.00	0	99.3321
.1oik.p1.OP	56.17	0.13	0.01	1.29	0.02	0.19	8.57	0.08	0.20	31.95	1.04	0.00	0.02	0.00	0	99.6717
.1oik.p1.OP	56.51	0.15	0.00	1.43	0.00	0.12	9.07	0.10	0.19	31.87	1.05	0.00	0.01	0.00	0	100.498
.1oik.p1.OP	56.58	0.10	0.00	1.27	0.01	0.24	9.37	0.08	0.20	31.94	1.15	0.00	0.01	0.00	0	100.932
.1oik.p1.OP	56.31	0.13	0.00	1.29	0.03	0.23	9.08	0.10	0.21	32.10	0.70	0.02	0.02	0.00	0	100.211
analysed as Plag																
SAMPLE	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	SrO	BaO	Na2O	K2O	O	H2O	TOTAL		
.plagioclase	57.12	0.12	1.34	7.64	0.19	33.61	0.66	0.00	0.03	0.00	0.02	0.00	0.00	100.74		
.plagioclase	55.63	0.12	1.35	7.50	0.18	32.93	0.72	0.00	0.02	0.00	0.02	0.00	0.00	98.47		
.plagioclase	56.92	0.12	1.51	8.05	0.17	33.22	0.55	0.00	0.00	0.00	0.01	0.00	0.00	100.56		
.plagioclase	56.04	0.13	1.42	7.83	0.18	33.05	0.74	0.00	0.12	0.01	0.02	0.00	0.00	99.54		
.plagioclase	57.84	0.12	1.31	7.63	0.20	32.73	0.74	0.00	0.00	0.02	0.02	0.00	0.00	100.62		
.plagioclase	56.94	0.13	1.19	7.74	0.18	33.65	0.55	0.00	0.01	0.01	0.02	0.00	0.00	100.42		
.plagioclase	56.25	0.11	1.21	7.28	0.16	33.32	0.60	0.00	0.07	0.00	0.02	0.00	0.00	99.03		
.plagioclase	56.88	0.11	1.42	7.88	0.19	33.36	0.64	0.00	0.00	0.00	0.02	0.00	0.00	100.51		

Table A8. Electron probe microanalysis for spot analyses on chromite.

SAMPLE	SiO2	TiO2	ZnO	Al2O3	V2O3	Cr2O3	FeO	NiO	MnO	MgO	CaO	Na2O	K2O	O	H2O	TOTAL
8.p1.chrm	-	0.33	0.09	13.40	0.30	41.36	36.49	0.15	0.36	5.14	0.00	0.00	0.02	1.23	-	98.90
8.p1.chrm	-	0.18	0.11	13.34	0.31	41.16	37.67	0.15	0.40	4.63	0.00	0.02	0.02	1.29	-	99.29
8.p1.chrm	-	0.88	0.09	13.90	0.29	43.77	33.55	0.19	0.37	6.07	0.01	-	0.03	0.96	-	100.11
8.p1.chrm	-	0.54	0.09	13.70	0.28	43.05	35.44	0.18	0.42	5.37	-	0.01	0.02	1.09	-	100.17
8.p1.chrm	-	0.44	0.08	12.92	0.28	43.55	34.74	0.16	0.38	5.32	0.01	0.01	0.04	1.07	-	98.99
8.p1.chrm	-	0.84	0.11	15.30	0.28	41.56	32.26	0.21	0.30	6.80	0.02	0.01	0.02	0.97	-	98.68
8.p1.chrm	-	1.08	0.11	13.09	0.29	42.80	33.03	0.22	0.30	6.55	-	0.02	0.03	1.04	-	98.56
8.p2.chrm	-	0.82	0.14	15.75	0.29	42.52	32.71	0.20	0.32	6.55	0.01	0.00	0.02	0.92	-	100.27
8.p2.chrm	-	0.90	0.06	14.54	0.30	43.00	32.58	0.18	0.33	7.11	0.02	-	0.03	1.01	-	100.06
8.p2.chrm	-	0.94	0.07	14.81	0.30	42.91	32.73	0.16	0.36	7.34	0.00	0.01	0.02	1.04	-	100.68
8.p2.chrm	-	0.97	0.09	14.40	0.31	43.34	32.58	0.19	0.37	6.98	0.01	-	0.04	0.99	-	100.27
8.p2.chrm	-	0.78	0.10	16.16	0.29	40.33	34.54	0.22	0.39	6.44	0.02	-	0.02	1.10	-	100.40
8.p2.chrm	-	0.86	0.13	15.55	0.29	41.35	34.28	0.22	0.29	6.44	0.00	0.02	0.03	1.07	-	100.53
8.p2.chrm	-	0.85	0.12	15.50	0.27	41.15	34.11	0.20	0.31	6.40	0.01	-	0.02	1.05	-	99.98
8.p2.chrm	-	0.90	0.14	12.00	0.29	44.60	35.80	0.20	0.36	5.37	0.00	0.02	0.03	1.11	-	100.82
8.p2.chrm	-	1.15	0.10	13.30	0.33	43.04	33.57	0.17	0.32	6.46	0.01	-	0.02	1.03	-	99.50
8.p3.chrm	-	0.83	0.12	13.61	0.32	44.40	33.80	0.16	0.40	6.18	0.01	0.01	0.03	1.00	-	100.86
8.p3.chrm	-	0.81	0.07	14.67	0.33	43.02	33.72	0.18	0.34	7.14	0.00	0.01	0.02	1.10	-	101.42
8.p3.chrm	-	0.93	0.09	13.60	0.32	44.40	33.43	0.15	0.36	6.03	0.03	0.01	0.02	0.93	-	100.31
8.p3.chrm	-	1.15	0.08	15.22	0.33	42.73	32.45	0.19	0.32	7.60	0.00	0.01	0.03	1.01	-	101.12
8.p3.chrm	-	0.70	0.11	13.66	0.30	44.00	33.34	0.19	0.39	6.48	0.99	-	0.02	1.12	-	101.29
8.p3.chrm	-	0.89	0.09	13.70	0.30	44.63	34.19	0.15	0.38	5.87	0.01	0.01	0.02	0.96	-	101.21
8.p3.chrm	-	1.15	0.10	14.81	0.30	43.91	32.06	0.21	0.29	7.58	0.01	-	0.02	0.95	-	101.38
8.p3.chrm	-	0.89	0.07	15.17	0.30	43.18	31.92	0.16	0.33	7.58	0.02	-	0.01	0.98	-	100.64
8.p3.chrm	-	0.98	0.08	15.28	0.30	43.06	32.13	0.19	0.30	7.64	-	-	0.03	0.99	-	100.98
8.p4.chrm	-	1.02	0.12	12.87	0.31	44.88	34.23	0.17	0.43	5.65	0.00	-	0.02	0.95	-	100.65
8.p4.chrm	-	1.00	0.08	13.18	0.31	45.02	33.74	0.16	0.38	5.92	-	0.02	0.03	0.93	-	100.76
8.p4.chrm	-	1.05	0.07	14.26	0.32	43.41	32.55	0.17	0.36	7.42	0.00	0.01	0.02	1.03	-	100.68
8.p4.chrm	-	0.91	0.13	12.62	0.33	42.52	38.46	0.19	0.56	3.37	0.01	-	0.03	1.09	-	100.22
8.p4.chrm	-	0.70	0.09	12.98	0.30	43.57	35.91	0.16	0.37	5.38	0.01	0.00	0.02	1.12	-	100.61
8.p4.chrm	-	0.95	0.08	12.95	0.30	43.58	36.48	0.17	0.41	4.64	0.02	-	0.02	1.03	-	100.63
8.p5.chrm	-	1.06	0.13	14.04	0.33	43.56	33.74	0.19	0.35	6.58	0.00	-	0.02	1.01	-	101.03
8.p5.chrm	-	0.51	0.06	14.11	0.33	43.25	36.05	0.13	0.47	4.51	0.01	-	0.03	0.99	-	100.43
8.p5.chrm	-	0.82	0.11	13.73	0.34	43.54	35.70	0.14	0.41	5.40	0.01	-	0.03	1.05	-	101.28
8.p5.chrm	-	1.02	0.11	14.25	0.32	43.22	34.18	0.18	0.36	6.90	0.00	-	0.02	1.09	-	101.66
8.p5.chrm	-	0.93	0.04	13.06	0.30	45.04	33.80	0.15	0.38	6.36	0.01	-	0.02	1.00	-	101.10
8.p6.chrm	-	0.82	0.09	14.80	0.28	42.88	34.29	0.21	0.34	6.52	0.00	-	0.02	1.06	-	101.32
8.p6.chrm	-	1.05	0.07	15.43	0.29	42.04	33.47	0.19	0.33	7.35	0.01	-	0.03	1.08	-	101.35
8.p6.chrm	-	0.94	0.08	15.21	0.28	42.03	33.05	0.20	0.36	7.44	0.06	-	0.03	1.09	-	100.78
8.p6.chrm	-	1.09	0.07	15.12	0.30	41.49	34.13	0.23	0.32	7.36	0.00	-	0.02	1.16	-	101.30
8.p6.chrm	-	1.01	0.11	15.74	0.27	42.61	33.65	0.19	0.31	6.86	0.04	0.01	0.03	1.00	-	101.82
8.p6.chrm	-	0.98	0.11	15.46	0.29	42.02	33.42	0.22	0.35	6.96	0.01	0.03	0.03	1.05	-	100.95
8.p7.chrm	-	0.95	0.10	15.49	0.27	41.96	33.63	0.19	0.34	7.31	0.00	-	0.04	1.10	-	101.39
8.p7.chrm	-	0.93	0.08	15.45	0.29	41.23	32.76	0.22	0.36	7.01	-	-	0.02	1.02	-	99.37
8.p7.chrm	-	0.88	0.10	15.72	0.27	41.05	33.26	0.21	0.34	7.07	-	-	0.02	1.07	-	99.99
8.p7.chrm	-	0.98	0.13	15.44	0.26	40.56	33.37	0.24	0.34	7.26	0.01	-	0.02	1.12	-	99.73
8.p7.chrm	-	1.04	0.10	15.04	0.30	38.95	36.02	0.27	0.34	6.52	0.01	-	0.01	1.29	-	99.89
8.p7.chrm	-	0.83	0.11	15.81	0.29	40.97	33.15	0.24	0.37	7.29	0.01	0.01	0.03	1.11	-	100.22
8.p7.chrm	-	0.90	0.10	15.24	0.27	41.33	32.52	0.21	0.35	7.21	0.00	0.01	0.03	1.05	-	99.23
8.p7.chrm	-	1.04	0.07	14.80	0.31	39.64	35.82	0.23	0.35	6.22	0.01	-	0.01	1.22	-	99.71
8.p7.chrm	-	0.82	0.13	15.59	0.29	39.56	34.30	0.22	0.32	6.41	0.01	0.01	0.02	1.13	-	98.81
8.p7.chrm	-	0.92	0.11	15.04	0.27	41.73	34.50	0.21	0.40	5.63	0.01	0.02	0.02	0.99	-	99.83
0.3.p2.chrr	-	2.03	0.15	14.75	0.35	32.44	41.82	0.24	0.32	5.98	0.00	-	0.02	1.76	-	99.85
0.3.p2.chrr	-	1.97	0.17	14.45	0.34	33.49	40.60	0.23	0.35	5.96	0.00	0.02	0.03	1.67	-	99.28
0.3.p2.chrr	-	1.96	0.16	14.58	0.39	33.33	41.16	0.22	0.35	5.96	0.00	-	0.03	1.70	-	99.83
0.3.p2.chrr	0.04	1.52	0.19	15.20	0.41	30.21	44.77	0.25	0.41	4.89	0.02	-	0.01	1.96	-	99.88
0.3.p2.chrr	0.52	1.02	0.23	15.28	0.39	30.30	44.27	0.18	0.36	4.85	0.02	0.02	0.03	1.89	-	99.36
0.3.p3.chrr	-	1.37	0.19	15.64	0.33	28.05	46.85	0.27	0.33	4.24	0.01	0.03	0.02	2.12	-	99.44
0.3.p3.chrr	-	1.52	0.20	14.75	0.36	28.58	47.90	0.27	0.41	3.37	0.00	-	0.02	2.08	-	99.47
0.3.p3.chrr	-	1.83	0.19	14.50	0.37	30.31	44.68	0.25	0.37	4.54	0.07	-	0.02	1.91	-	99.02
0.3.p3.chrr	-	1.27	0.22	15.31	0.35	29.91	45.33	0.24	0.39	3.93	0.00	0.00	0.03	1.92	-	98.90
0.3.p3.chrr	-	1.30	0.20	15.62	0.38	30.47	44.36	0.24	0.35	4.77	-	-	0.01	1.91	-	99.61
0.3.p3.chrr	-	1.28	0.23	16.28	0.35	27.31	47.97	0.28	0.33	3.69	0.04	0.00	0.01	2.13	-	99.92
0.3.p3.chrr	-	1.39	0.17	15.59	0.35	30.04	44.82	0.27	0.36	4.72	-	0.00	0.02	1.95	-	99.70
0.3.p3.chrr	-	1.36	0.25	16.72	0.33	26.64	46.53	0.25	0.33	4.26	0.02	0.03	0.02	2.09	-	98.82
0.3.p3.chrr	-	1.74	0.16	14.35	0.39	30.57	45.25	0.23	0.39	4.70	0.01	-	0.02	1.98	-	99.78
0.3.p3.chrr	-	1.91	0.17	14.25	0.35	29.90	45.85	0.26	0.36	4.57	0.02	0.01	0.03	2.02	-	99.69
0.3.p4.chrr	0.60	1.53	0.20	13.89	0.36	36.28	38.50	0.21	0.39	6.24	0.01	0.02	0.03	1.43	-	99.68
0.3.p4.chrr	-	1.46	0.16	14.45	0.36	38.41	37.63	0.23	0.37	6.00	0.02	0.01	0.03	1.35	-	100.46
0.3.p4.chrr	-	1.74	0.11	14.14	0.38	29.55	44.93	0.22	0.31	5.31	0.37	-	0.02	2.10	-	99.18
0.3.p4.chrr	0.11	1.20	0.22	17.67	0.34	32.12	39.77	0.19	0.32	5.80	0.10	0.00	0.03	1.55	-	99.42
0.3.p4.chrr	3.86	1.56	0.13	12.59	0.34	26.34	46.33	0.21	0.31	7.09	0.02	0.00	0.03	1.95	-	100.77
0.3.p4.chrr	-	1.89	0.17	15.34	0.37	31.94	42.04	0.25	0.33	5.72	0.00	0.02	0.02	1.76	-	99.87
0.3.p4.chrr	-	1.91	0.14	15.24	0.42	31.87	42.23	0.23	0.31	5.82	0.00	-	0.02	1.78	-	99.97
0.3.p4.chrr	-	1.81	0.17	15.73	0.36	32.36	41.73	0.23	0.31	5.69	0.00	-	0.02	1.70	-	100.11
0.3.p5.chrr	-	1.51	0.13	17.16	0.33	36.43	35.52	0.20	0.33	7.33	0.01	0.02	0.02	1.28	-	100.28
0.3.p5.chrr	-	1.57	0.12	16.87	0.33	36.88	34.37	0.24	0.28	7.70	0.00	-	0.02	1.23	-	99.59
0.3.p5.chrr	-	1.64	0.11	16.70	0.35	36.42	34.17	0.23	0.29	7.52	0.01	-	0.02	1.20	-	98.67
0.3.p5.chrr	-	1.64	0.06	16.98	0.32	36.74	34.67	0.22	0.28	7.64	0.00	-	0.02	1.22		

0.3.p6.chrr	-	2.84	0.18	13.22	0.42	29.35	46.03	0.28	0.35	4.53	0.02	0.01	0.03	1.97	-	99.22
0.3.p6.chrr	-	2.25	0.26	12.27	0.45	30.27	47.09	0.25	0.39	3.29	0.01	0.00	0.01	1.98	-	98.52
7.2.p2.chrr	-	0.74	0.07	16.66	0.27	42.48	25.27	0.20	0.26	9.98	0.01	-	0.01	0.77	-	96.72
7.2.p2.chrr	-	0.65	0.07	17.41	0.27	43.60	26.68	0.17	0.27	10.45	0.00	-	0.03	0.87	-	100.48
7.2.p2.chrr	-	0.71	0.08	16.83	0.25	42.65	25.65	0.19	0.25	10.16	0.01	-	0.02	0.81	-	97.60
7.2.p2.chrr	-	0.73	0.07	17.35	0.29	42.87	26.01	0.19	0.26	10.17	0.01	0.02	0.03	0.81	-	98.81
7.2.p2.chrr	-	0.74	0.07	17.24	0.27	42.98	26.31	0.16	0.30	10.24	0.01	-	0.01	0.83	-	99.16
7.2.p2.chrr	-	0.69	0.04	17.28	0.27	43.94	26.73	0.20	0.30	10.65	-	-	0.01	0.89	-	101.01
7.2.p2.chrr	-	0.68	0.08	17.30	0.28	43.16	27.24	0.17	0.31	9.66	0.01	-	0.02	0.83	-	99.73
7.2.p2.chrr	-	0.65	0.06	16.85	0.26	43.23	25.97	0.18	0.29	10.21	-	0.02	0.02	0.84	-	98.58
7.2.p2.chrr	-	0.72	0.09	15.80	0.28	41.97	25.37	0.15	0.27	9.08	0.00	-	0.03	0.73	-	94.49
7.2.p2.chrr	-	0.66	0.03	16.58	0.24	42.39	25.96	0.19	0.30	9.23	-	0.01	0.01	0.74	-	96.34
7.2.p3.chrr	-	0.63	0.14	16.86	0.29	42.81	27.75	0.17	0.25	10.29	0.02	0.02	0.01	1.00	-	100.23
7.2.p3.chrr	-	0.61	0.09	16.71	0.26	42.88	26.01	0.16	0.30	10.19	-	-	0.02	0.85	-	98.07
7.2.p3.chrr	-	0.85	0.09	16.79	0.29	41.78	25.81	0.16	0.28	9.75	0.01	-	0.03	0.78	-	96.62
7.2.p3.chrr	-	0.73	0.11	16.86	0.26	41.51	25.99	0.17	0.30	9.69	-	-	0.02	0.81	-	96.45
7.2.p3.chrr	-	0.68	0.11	16.85	0.27	42.12	26.32	0.17	0.29	9.95	0.00	-	0.03	0.86	-	97.64
7.2.p3.chrr	-	0.66	0.04	16.18	0.30	42.35	26.13	0.18	0.30	10.15	0.00	-	0.02	0.90	-	97.22
7.2.p3.chrr	-	0.60	0.06	17.06	0.27	41.77	26.56	0.17	0.28	9.70	0.01	-	0.01	0.85	-	97.35
7.2.p4.chrr	-	1.23	0.03	16.63	0.30	42.97	27.87	0.17	0.26	10.11	0.01	0.01	0.02	0.90	-	100.51
7.2.p4.chrr	-	0.70	0.07	16.60	0.28	42.71	26.54	0.17	0.27	10.13	0.01	-	0.02	0.88	-	98.38
7.2.p4.chrr	-	0.71	0.05	16.83	0.26	42.93	26.51	0.18	0.27	10.19	0.00	0.03	0.02	0.88	-	98.86
7.2.p4.chrr	-	0.68	0.08	16.52	0.26	43.01	26.49	0.13	0.28	10.01	0.00	0.00	0.03	0.87	-	98.38
7.2.p4.chrr	-	0.78	0.08	16.64	0.28	43.24	26.71	0.18	0.30	10.27	0.01	-	0.02	0.89	-	99.40
7.2.p4.chrr	-	0.76	0.09	16.61	0.30	42.58	26.36	0.18	0.32	10.15	-	0.01	0.03	0.88	-	98.26
7.2.p4.chrr	-	0.67	0.08	17.13	0.27	42.24	26.39	0.18	0.29	10.39	0.01	-	0.02	0.90	-	98.56
7.2.p4.chrr	-	0.78	0.05	16.98	0.31	42.11	27.22	0.19	0.32	9.58	0.02	0.01	0.01	0.86	-	98.44
7.2.p4.chrr	-	0.77	0.09	16.42	0.29	42.12	26.92	0.17	0.31	9.91	0.02	-	0.01	0.91	-	97.95
7.2.p5.chrr	-	0.75	0.06	16.93	0.28	42.70	26.94	0.16	0.31	10.32	-	-	0.02	0.92	-	99.37
7.2.p5.chrr	-	0.70	0.08	16.59	0.28	43.37	27.40	0.17	0.30	10.34	-	0.00	0.02	0.96	-	100.21
7.2.p5.chrr	-	0.68	0.06	16.93	0.27	42.82	27.27	0.19	0.30	10.19	-	-	0.01	0.92	-	99.64
7.2.p5.chrr	-	0.78	0.05	16.66	0.27	44.00	27.07	0.20	0.33	10.01	0.01	0.03	0.02	0.87	-	100.30
7.2.p5.chrr	-	0.73	0.10	16.73	0.26	44.09	27.55	0.18	0.31	10.07	0.01	-	0.02	0.90	-	100.95
7.2.p5.chrr	-	0.81	0.09	17.09	0.27	42.97	27.19	0.18	0.29	10.19	0.01	-	0.02	0.89	-	100.00
7.2.p5.chrr	-	0.62	0.10	16.85	0.30	43.41	26.44	0.19	0.25	10.04	0.01	-	0.02	0.84	-	99.06
7.2.p6.chrr	-	0.69	0.05	16.53	0.30	42.86	29.64	0.15	0.31	9.78	0.02	0.01	0.02	1.07	-	101.42
7.2.p6.chrr	-	0.74	0.09	16.65	0.27	43.74	27.60	0.19	0.33	9.80	0.02	-	0.03	0.88	-	100.34
7.2.p6.chrr	-	0.71	0.08	16.70	0.26	43.48	27.57	0.21	0.31	10.19	0.01	-	0.03	0.94	-	100.49
7.2.p6.chrr	-	0.77	0.07	16.28	0.24	42.94	27.21	0.17	0.31	9.55	0.01	0.01	0.03	0.87	-	98.47
7.2.p6.chrr	-	0.77	0.11	16.71	0.26	43.51	28.03	0.16	0.31	9.46	0.01	-	0.02	0.87	-	100.21
7.2.p6.chrr	-	0.77	0.08	16.64	0.28	43.70	28.22	0.17	0.33	9.20	0.00	-	0.04	0.85	-	100.29
7.2.p6.chrr	-	0.76	0.06	16.92	0.27	42.72	29.03	0.20	0.29	9.29	0.02	0.02	0.02	0.94	-	100.53
7.2.p6.chrr	-	0.67	0.07	16.85	0.26	43.14	28.52	0.18	0.34	9.42	0.03	0.01	0.01	0.92	-	100.42
7.2.p7.chrr	1.04	0.68	0.05	16.43	0.27	43.11	26.43	0.16	0.29	10.56	0.05	-	0.02	0.75	-	99.86
7.2.p7.chrr	-	0.68	0.09	17.76	0.26	42.68	27.41	0.19	0.27	10.15	-	-	0.02	0.90	-	100.41
7.2.p7.chrr	-	0.75	0.09	16.68	0.30	43.33	26.80	0.17	0.29	10.03	0.00	0.01	0.03	0.86	-	99.34
7.2.p7.chrr	-	0.82	0.08	17.12	0.27	42.40	27.27	0.18	0.32	9.52	0.01	-	0.02	0.83	-	98.85
7.2.p7.chrr	-	0.70	0.11	16.93	0.27	43.39	28.22	0.18	0.32	8.99	0.01	-	0.02	0.83	-	99.99
7.2.p7.chrr	-	0.72	0.08	16.97	0.29	44.05	27.88	0.17	0.33	9.43	0.00	-	0.02	0.83	-	100.77
7.2.p7.chrr	51.12	0.02	0.02	30.59	0.01	0.07	0.14	-	0.02	0.01	13.81	3.77	0.05	-	-	99.63
7.2.p7.chrr	-	0.79	0.07	16.52	0.26	43.50	27.45	0.18	0.36	9.68	0.00	-	0.02	0.86	-	99.69
7.2.p7.chrr	-	0.81	0.05	16.02	0.29	43.42	28.02	0.20	0.31	9.12	0.00	0.02	0.01	0.86	-	99.13
7.2.p7.chrr	-	0.78	0.07	15.89	0.27	43.88	28.72	0.19	0.30	8.53	0.04	0.01	0.02	0.83	-	99.54
7.2.p8.chrr	-	0.54	0.08	16.79	0.29	43.20	28.93	0.17	0.34	9.71	0.02	-	0.03	1.01	-	101.11
7.2.p8.chrr	-	0.57	0.09	16.94	0.27	43.92	27.53	0.17	0.29	9.72	0.01	-	0.02	0.86	-	100.38
7.2.p8.chrr	-	0.60	0.03	16.95	0.28	43.23	29.03	0.16	0.34	8.44	0.01	-	0.03	0.83	-	99.94
7.2.p8.chrr	-	0.58	0.10	16.70	0.25	43.18	28.31	0.15	0.30	9.46	0.00	-	0.02	0.92	-	99.97
7.2.p8.chrr	-	0.72	0.09	15.69	0.27	43.27	29.82	0.17	0.36	7.96	0.01	0.02	0.03	0.88	-	99.28
7.2.p8.chrr	-	0.64	0.09	16.61	0.28	44.02	28.69	0.15	0.38	8.82	0.00	0.00	0.03	0.84	-	100.55
7.2.p8.chrr	-	0.81	0.08	16.60	0.27	43.46	29.23	0.18	0.35	8.31	0.01	0.02	0.03	0.82	-	100.17
7.2.p8.chrr	-	0.82	0.07	15.62	0.28	43.70	31.21	0.17	0.36	7.47	-	-	0.03	0.89	-	100.62
7.2.p8.chrr	-	0.85	0.09	16.50	0.29	43.58	29.93	0.16	0.39	8.15	0.03	0.01	0.03	0.85	-	100.85
7.2.p9.chrr	-	0.74	0.08	17.36	0.29	42.31	28.28	0.20	0.31	9.59	0.00	-	0.01	0.91	-	100.11
7.2.p9.chrr	-	0.75	0.05	16.64	0.30	43.57	29.56	0.18	0.33	8.47	0.01	-	0.03	0.85	-	100.75
.chrm (cont	-	0.87	0.06	16.37	0.27	43.68	28.86	0.17	0.35	8.75	0.01	-	0.04	0.84	-	100.28
.chrm (cont	-	0.89	0.06	17.05	0.25	42.36	29.24	0.20	0.33	8.62	-	0.01	0.03	0.86	-	99.92
.chrm (cont	-	0.95	0.05	16.27	0.28	42.35	31.22	0.20	0.41	7.20	-	-	0.01	0.85	-	99.79
.chrm (cont	-	0.95	0.06	16.14	0.27	43.70	28.59	0.24	0.29	8.90	0.00	-	0.02	0.83	-	100.02
.chrm (cont	-	0.70	0.07	16.14	0.29	42.56	32.98	0.17	0.40	6.31	0.00	-	0.03	0.90	-	100.55
.chrm (cont	-	0.82	0.07	16.60	0.25	42.20	31.79	0.19	0.42	6.22	-	0.01	0.01	0.77	-	99.36
.2.p10.chrr	-	1.15	0.06	16.25	0.29	43.03	29.56	0.20	0.29	8.99	0.00	-	0.02	0.91	-	100.77
.2.p10.chrr	-	0.67	0.06	15.57	0.28	42.80	34.47	0.16	0.44	4.95	0.01	-	0.02	0.85	-	100.29
.2.p10.chrr	-	0.63	0.09	15.69	0.29	42.75	33.42	0.14	0.43	5.48	0.00	-	0.03	0.85	-	99.80
.2.p10.chrr	-	0.77	0.07	16.36	0.25	42.75	29.78	0.18	0.33	8.68	-	0.01	0.02	0.94	-	100.15
.2.p10.chrr	-	0.66	0.06	16.19	0.28	43.71	32.65	0.12	0.48	5.97	0.03	0.01	0.04	0.80	-	100.99
.2.p10.chrr	-	0.57	0.07	15.69	0.30	42.24	34.01	0.12	0.53	5.08	0.01	-	0.02	0.87	-	99.50
.2.p10.chrr	-	0.70	0.07	15.73	0.26	42.37	33.21	0.15	0.46	6.01	0.01	0.01	0.03	0.91	-	99.92
.2.p10.chrr	-	0.64	0.02	15.65	0.28	43.07	32.48	0.12	0.42	6.47	0.01	-	0.01	0.89	-	100.06
.2.p10.chrr	-	0.67	0.10	15.60	0.30	43.06	32.60	0.16	0.47	6.36	-	0.01	0.02	0.90	-	100.24
3.4.p1.chrr	-	0.74	0.08	18.47	0.29	41.43	28.21	0.18	0.25	10.56	0.02	-	0.03	1.01	-</	

3.4.p2.chrrr	-	1.06	0.06	18.13	0.31	42.30	27.45	0.15	0.31	10.37	0.00	-	0.02	0.87	-	101.05
3.4.p2.chrrr	-	0.71	0.06	18.26	0.30	41.64	27.66	0.19	0.26	10.48	0.01	-	0.02	0.96	-	100.55
3.4.p2.chrrr	-	0.82	0.08	18.28	0.28	41.73	27.76	0.17	0.27	10.31	0.01	-	0.02	0.93	-	100.66
3.4.p2.chrrr	-	0.77	0.08	17.91	0.28	42.06	27.60	0.20	0.25	10.30	0.01	-	0.01	0.93	-	100.39
3.4.p2.chrrr	-	0.77	0.05	17.99	0.27	41.84	27.95	0.17	0.29	10.31	0.01	-	0.03	0.96	-	100.65
3.4.p3.chrrr	-	1.77	0.07	17.01	0.27	41.69	29.44	0.16	0.26	10.06	-	0.01	0.03	0.96	-	101.74
3.4.p3.chrrr	-	0.79	0.06	17.61	0.31	42.08	27.98	0.16	0.29	9.90	-	0.00	0.01	0.92	-	100.11
3.4.p3.chrrr	-	0.65	0.11	18.14	0.29	41.94	27.69	0.18	0.29	10.11	0.01	-	0.02	0.93	-	100.36
3.4.p3.chrrr	-	0.69	0.03	17.71	0.28	42.47	27.84	0.16	0.27	10.12	-	0.01	0.02	0.93	-	100.54
3.4.p3.chrrr	-	0.76	0.05	17.83	0.30	41.68	28.21	0.19	0.30	10.19	-	0.00	0.03	0.99	-	100.52
3.4.p3.chrrr	-	0.65	0.07	18.08	0.29	41.79	27.59	0.15	0.30	10.25	-	-	0.02	0.94	-	100.11
3.4.p3.chrrr	-	0.66	0.06	17.81	0.29	42.41	28.03	0.17	0.36	10.00	0.10	-	0.01	0.94	-	100.86
3.4.p3.chrrr	-	0.63	0.07	17.70	0.28	43.03	27.31	0.17	0.27	10.08	0.00	-	0.02	0.87	-	100.44
3.4.p4.chrrr	-	0.78	0.08	17.74	0.31	42.11	28.61	0.19	0.30	10.11	0.01	-	0.03	0.99	-	101.25
3.4.p4.chrrr	-	0.80	0.05	17.60	0.30	42.13	28.27	0.17	0.29	9.98	0.01	-	0.02	0.95	-	100.57
3.4.p4.chrrr	-	0.76	0.07	17.41	0.31	42.50	27.83	0.18	0.26	9.98	0.01	-	0.01	0.91	-	100.24
3.4.p4.chrrr	-	0.78	0.11	17.94	0.30	41.52	27.95	0.18	0.25	10.18	0.00	0.01	0.01	0.96	-	100.18
3.4.p4.chrrr	-	0.80	0.07	17.35	0.30	42.37	28.82	0.17	0.29	9.93	-	-	0.02	0.99	-	101.10
3.4.p4.chrrr	-	0.78	0.07	17.37	0.28	42.44	28.27	0.16	0.26	10.00	0.01	-	0.02	0.95	-	100.60
3.4.p4.chrrr	-	0.78	0.09	17.07	0.30	42.93	28.51	0.17	0.30	10.00	-	-	0.02	0.97	-	101.15
3.4.p4.chrrr	-	0.96	0.07	18.03	0.26	41.26	27.97	0.18	0.25	10.00	0.01	-	0.03	0.92	-	99.94
3.4.p5.chrrr	-	1.77	0.10	16.29	0.36	37.25	34.37	0.24	0.35	8.96	-	0.01	0.02	1.39	-	101.11
3.4.p5.chrrr	-	1.66	0.08	16.44	0.40	36.42	32.82	0.20	0.34	8.97	0.01	0.02	0.02	1.31	-	98.70
3.4.p5.chrrr	-	2.01	0.09	16.59	0.36	36.05	34.32	0.26	0.30	8.97	0.02	-	0.02	1.38	-	100.38
3.4.p5.chrrr	-	1.82	0.06	16.52	0.38	36.37	34.12	0.22	0.33	9.15	0.00	-	0.02	1.40	-	100.40
3.4.p5.chrrr	-	1.48	0.02	16.10	0.35	39.55	31.94	0.24	0.34	9.06	-	-	0.02	1.18	-	100.29
3.4.p6.chrrr	0.80	3.92	0.09	12.19	0.43	31.41	41.08	0.39	0.48	6.13	0.04	0.01	0.03	1.52	-	98.51
3.4.p6.chrrr	1.41	2.85	0.09	12.60	0.45	32.35	39.70	0.32	0.44	6.05	0.26	-	0.03	1.40	-	97.95
3.4.p6.chrrr	-	3.30	0.09	12.65	0.45	33.13	41.61	0.34	0.38	5.88	0.03	0.00	0.01	1.65	-	99.52
3.4.p6.chrrr	-	3.35	0.05	12.37	0.43	31.94	42.57	0.34	0.35	6.09	0.01	0.01	0.02	1.80	-	99.32
3.4.p6.chrrr	-	2.97	0.10	12.88	0.44	33.57	40.88	0.33	0.36	5.95	0.00	-	0.02	1.62	-	99.11
3.4.p7.chrrr	-	1.64	0.02	15.97	0.40	37.07	33.48	0.28	0.31	8.74	0.01	-	0.03	1.33	-	99.28
3.4.p7.chrrr	-	1.56	0.02	16.06	0.43	38.17	32.79	0.25	0.35	8.70	0.01	-	0.03	1.24	-	99.60
3.4.p7.chrrr	-	1.46	0.08	16.13	0.44	37.90	33.04	0.21	0.34	8.60	0.00	0.01	0.02	1.26	-	99.51
3.4.p7.chrrr	-	1.47	0.08	16.21	0.43	37.43	32.68	0.24	0.31	8.72	0.01	-	0.02	1.26	-	98.88
3.4.p7.chrrr	-	1.60	0.08	17.02	0.40	36.92	32.50	0.29	0.31	8.92	0.01	0.00	0.03	1.24	-	99.31
3.4.p8.chrrr	-	3.26	0.14	11.85	0.48	30.58	45.38	0.30	0.37	4.68	0.02	0.01	0.02	1.91	-	99.00
3.4.p8.chrrr	-	2.86	0.10	12.01	0.46	31.22	44.81	0.28	0.36	4.59	-	0.02	0.02	1.88	-	98.60
3.4.p8.chrrr	-	3.92	0.15	11.88	0.41	31.62	43.84	0.21	0.35	4.39	0.00	-	0.03	1.63	-	98.44
3.4.p8.chrrr	-	1.57	0.16	11.17	0.43	33.25	47.47	0.14	0.37	2.12	0.01	0.02	0.03	1.90	-	98.64
3.4.p8.chrrr	-	2.48	0.14	11.67	0.45	32.94	45.63	0.23	0.37	3.50	-	0.01	0.02	1.80	-	99.24
3.4.p8.chrrr	-	2.88	0.17	11.38	0.41	33.52	43.64	0.26	0.41	3.64	0.01	-	0.02	1.62	-	97.95
3.4.p8.chrrr	-	2.69	0.15	12.63	0.40	35.72	39.38	0.33	0.29	5.60	0.00	0.02	0.04	1.45	-	98.70
3.4.p9.chrrr	-	0.80	0.05	17.35	0.28	42.05	28.18	0.16	0.27	9.80	-	-	0.01	0.93	-	99.87
3.4.p9.chrrr	-	0.80	0.07	17.23	0.29	42.65	28.18	0.18	0.32	9.84	-	0.02	0.02	0.93	-	100.54
3.4.p9.chrrr	-	0.72	0.09	17.67	0.29	43.30	27.85	0.19	0.31	10.07	0.01	-	0.02	0.90	-	101.41
3.4.p9.chrrr	-	0.83	0.06	17.48	0.29	41.70	27.94	0.18	0.31	9.88	0.01	-	0.03	0.93	-	99.66
3.4.p9.chrrr	-	0.82	0.10	17.56	0.31	41.85	27.29	0.21	0.25	9.89	0.01	-	0.01	0.87	-	99.17
3.4.p9.chrrr	-	0.77	0.14	17.74	0.30	41.80	27.85	0.18	0.27	9.95	0.01	0.00	0.02	0.93	-	99.97
2.p1.chrom	-	0.76	0.08	18.60	0.25	41.08	27.70	0.19	0.28	10.16	0.01	-	0.01	0.00	-	99.1143
2.p1.chrom	-	0.78	0.03	18.75	0.26	41.44	28.56	0.20	0.28	10.40	-	-	0.03	-	-	100.712
2.p1.chrom	-	0.79	-	18.95	0.22	40.89	28.43	0.19	0.27	10.45	0.01	0.01	0.02	0.00	-	100.22
2.p1.chrom	-	0.77	0.05	19.09	0.22	40.22	28.38	0.23	0.27	10.54	0.02	0.00	0.02	0.00	-	99.8324
2.p1.chrom	-	0.79	-	19.29	0.23	40.79	28.80	0.19	0.25	10.56	0.01	-	0.01	-	-	100.92
2.p1.chrom	-	0.78	-	19.14	0.24	41.21	28.30	0.21	0.27	10.44	-	0.00	0.02	0.00	-	100.615
2.p1.chrom	-	0.78	0.00	18.86	0.26	41.27	28.36	0.20	0.30	10.61	0.00	-	0.02	0.00	-	100.666
2.p1.chrom	-	0.78	0.08	18.61	0.24	40.95	28.66	0.20	0.29	10.07	0.00	-	0.02	0.00	-	99.9161
2.p1.chrom	-	0.79	0.05	18.82	0.23	41.46	28.90	0.17	0.30	10.40	0.01	-	0.04	-	-	101.146
2.p1.chrom	-	0.74	-	19.05	0.22	40.50	28.77	0.17	0.30	10.35	0.01	0.02	0.02	-	-	100.158
2.p1.chrom	-	0.75	0.10	19.05	0.27	40.68	28.87	0.18	0.28	10.45	0.00	0.01	0.03	-	-	100.661
2.p1.chrom	-	0.78	0.03	18.72	0.21	41.01	28.48	0.17	0.26	10.30	-	0.00	0.03	-	-	99.9782
2.p1.chrom	-	0.77	0.01	18.86	0.22	40.68	28.37	0.16	0.27	10.08	-	0.01	0.02	0.00	-	99.4612
2.p4.chrom	-	0.79	0.06	19.99	0.23	40.75	26.91	0.17	0.27	10.71	0.01	0.00	0.02	0.00	-	99.9145
2.p4.chrom	-	0.79	0.13	19.33	0.23	42.06	27.02	0.17	0.29	10.80	0.01	-	0.01	-	-	100.835
2.p4.chrom	-	0.72	0.16	19.14	0.21	41.46	27.11	0.15	0.29	10.62	0.00	0.02	0.02	0.00	-	99.8961
2.p4.chrom	-	0.77	-	19.08	0.27	42.06	27.00	0.17	0.28	10.62	-	-	0.02	0.00	-	100.273
2.p4.chrom	-	0.77	0.04	19.14	0.25	41.97	27.23	0.14	0.29	10.59	0.01	0.01	0.01	-	-	100.442
2.p4.chrom	-	0.77	0.15	18.76	0.25	43.04	26.96	0.15	0.26	10.80	-	-	0.02	-	-	101.161
2.p4.chrom	-	0.75	0.05	18.69	0.23	42.86	27.06	0.17	0.25	10.38	0.01	-	0.02	-	-	100.48
2.p4.chrom	-	0.70	0.10	19.79	0.24	41.54	26.18	0.19	0.30	10.78	0.01	-	0.02	-	-	99.8376
2.p4.chrom	-	0.78	0.04	19.17	0.21	42.90	26.41	0.16	0.28	10.85	0.00	0.00	0.03	0.00	-	100.83
2.p4.chrom	-	0.69	0.01	20.27	0.25	40.19	27.01	0.17	0.23	10.61	0.00	-	0.01	-	-	99.4448
2.p4.chrom	-	0.78	0.10	19.35	0.25	41.47	26.85	0.18	0.25	10.30	0.00	0.02	0.02	-	-	99.5662
2.p4.chrom	-	0.74	-	19.33	0.25	42.06	27.15	0.16	0.27	10.41	0.00	-	0.02	-	-	100.38
2.p4.chrom	-	0.78	0.07	18.95	0.26	42.61	26.94	0.17	0.31	10.64	0.01	-	0.02	-	-	100.758
2.p7.chrom	-	0.75	0.13	18.91	0.25	42.62	27.14	0.17	0.26	10.77	-	0.02	0.02	0.00	-	101.049
2.p7.chrom	-	0.77	0.11	18.82	0.26	43.03	26.67	0.19	0.29	10.59	0.00	0.00	0.02	0.00	-	100.759
2.p7.chrom	-	0.75	0.03	18.80	0.25	42.25	26.81	0.15	0.24	10.39	0.06	-	0.03	-	-	99.7749
2.p7.chrom	-	0.71	0.07	18.95	0.20	43.10	26.56	0.15	0.32	10.52	0.03	-	0.01	-	-	100.624
2.p7.chrom	-	0.69	0.12	19.16	0.23	43.02	26.26	0.14	0.28	10.66	0.00	0.01	0.02	-	-	100.58

2.p8.chrom	-	0.78	0.08	19.42	0.26	41.86	27.36	0.16	0.25	10.26	0.01	-	0.02	-	-	100.471
2.p8.chrom	-	0.78	0.08	19.14	0.24	41.94	27.11	0.18	0.22	10.33	-	0.01	0.02	-	-	100.04
2.p8.chrom	-	0.77	-	19.06	0.23	43.18	26.27	0.14	0.29	10.52	-	-	0.03	-	-	100.495
2.p8.chrom	-	0.78	0.07	19.21	0.21	42.54	26.82	0.16	0.29	10.46	0.01	0.00	0.01	-	-	100.568
2.p8.chrom	-	0.74	0.07	18.95	0.22	42.46	26.38	0.19	0.31	10.33	0.03	-	0.01	-	-	99.6801
2.p8.chrom	-	0.74	0.13	18.74	0.21	42.74	26.59	0.15	0.26	10.47	0.01	0.01	0.03	0.00	-	100.095
2.p8.chrom	-	0.77	0.01	19.02	0.27	42.48	26.90	0.17	0.25	10.24	0.00	-	0.02	-	-	100.142
2.p8.chrom	-	0.78	0.02	19.00	0.21	42.69	26.81	0.17	0.28	10.45	0.01	0.02	0.02	-	-	100.466
2.p8.chrom	-	0.68	0.01	19.02	0.22	42.80	26.32	0.16	0.32	10.36	-	0.02	0.01	0.00	-	99.9218
2.p1.chrom	-	1.43	0.12	10.76	0.40	43.99	35.57	0.18	0.36	6.01	0.02	-	0.02	0.00	-	98.8498
2.p1.chrom	-	1.18	0.07	11.00	0.36	44.24	35.20	0.14	0.39	6.03	0.02	-	0.02	-	-	98.6493
2.p1.chrom	-	1.61	0.01	10.49	0.32	44.34	35.66	0.19	0.36	5.99	0.00	0.02	0.03	0.00	-	99.0241
2.p1.chrom	-	1.36	0.12	10.55	0.36	44.49	35.89	0.17	0.36	5.89	0.01	-	0.02	0.00	-	99.2065
2.p1.chrom	-	1.48	0.10	10.79	0.35	44.05	35.97	0.17	0.35	6.02	0.02	-	0.02	0.00	-	99.3206
2.p1.chrom	-	1.68	0.04	10.35	0.35	43.74	36.32	0.20	0.37	5.93	0.01	-	0.02	-	-	99.0115
2.p1.chrom	-	1.48	0.09	10.42	0.35	43.99	36.19	0.17	0.35	5.85	0.00	0.02	0.02	0.00	-	98.9246
2.p1.chrom	-	1.28	-	10.86	0.33	44.47	35.02	0.17	0.35	6.07	0.00	-	0.03	0.00	-	98.5874
2.p1.chrom	-	1.50	0.19	10.67	0.34	44.32	35.72	0.21	0.35	6.02	0.01	0.00	0.01	0.00	-	99.3549
2.p1.chrom	-	1.51	0.07	10.67	0.34	44.39	35.24	0.19	0.34	6.12	0.01	0.01	0.02	-	-	98.9034
2.p1.chrom	-	1.25	0.04	13.33	0.27	45.07	32.40	0.17	0.35	7.06	-	0.01	0.03	0.00	-	99.9533
2.p2.chrom	-	1.13	0.08	13.18	0.27	44.50	32.80	0.17	0.33	6.81	-	-	0.02	-	-	99.2698
2.p2.chrom	-	1.12	0.05	13.60	0.29	44.69	31.95	0.16	0.30	7.17	0.05	-	0.03	0.00	-	99.4251
2.p2.chrom	-	1.20	0.12	13.46	0.29	44.64	31.97	0.18	0.36	7.18	0.01	-	0.03	0.00	-	99.4248
2.p2.chrom	-	0.98	0.05	13.39	0.28	44.70	32.30	0.17	0.32	6.97	0.06	-	0.02	-	-	99.2478
2.p2.chrom	-	1.14	-	13.08	0.31	45.40	31.76	0.16	0.32	7.12	0.04	-	0.03	-	-	99.3444
2.p2.chrom	-	1.19	0.12	13.13	0.31	45.01	32.36	0.18	0.29	7.03	0.02	0.02	0.03	-	-	99.6852
2.p2.chrom	-	1.08	0.18	13.43	0.32	44.64	32.39	0.18	0.33	7.13	0.04	0.03	0.02	0.00	-	99.7939
2.p2.chrom	-	1.27	0.12	13.31	0.28	44.37	32.42	0.18	0.34	7.14	0.01	-	0.01	-	-	99.4595
2.p3.chrom	-	1.07	0.12	13.65	0.26	44.60	32.61	0.16	0.38	6.89	0.02	-	0.02	0.00	-	99.7824
2.p3.chrom	-	0.96	0.06	13.59	0.27	44.76	32.48	0.17	0.35	6.76	0.06	0.00	0.03	-	-	99.4892
2.p3.chrom	-	1.05	-	13.56	0.27	45.17	32.48	0.17	0.33	6.79	0.03	-	0.01	-	-	99.8536
hromite (co	-	1.04	0.05	13.37	0.25	45.04	32.64	0.17	0.35	6.80	0.03	0.01	0.02	0.00	-	99.7613
hromite (co	-	1.16	0.07	12.80	0.30	44.81	32.93	0.17	0.37	6.69	0.07	-	0.02	-	-	99.4163
hromite (co	-	1.18	-	12.72	0.27	45.18	32.85	0.18	0.37	6.79	0.01	0.01	0.02	0.00	-	99.57
hromite (co	-	0.96	0.07	14.84	0.27	43.90	31.71	0.16	0.36	7.36	0.03	0.00	0.02	-	-	99.6757
hromite (co	-	0.96	0.15	14.92	0.28	43.98	31.62	0.17	0.31	7.53	0.01	-	0.02	-	-	99.9595
hromite (co	-	0.93	0.16	14.93	0.22	44.12	31.77	0.15	0.31	7.30	0.02	0.01	0.02	0.00	-	99.9497
hromite (co	-	0.90	0.05	14.88	0.24	44.08	31.40	0.17	0.36	7.41	0.08	-	0.02	-	-	99.5825
2.p4.chrom	-	1.33	0.18	11.95	0.30	45.01	34.03	0.18	0.36	6.42	0.07	-	0.01	-	-	99.8288
2.p4.chrom	-	1.46	0.09	11.89	0.33	44.62	34.00	0.21	0.34	6.50	0.01	0.00	0.02	0.00	-	99.4541
2.p4.chrom	-	1.35	0.03	12.72	0.30	44.42	32.58	0.18	0.33	6.97	0.02	-	0.02	-	-	98.9258
2.p4.chrom	-	1.27	0.08	12.78	0.32	44.45	33.38	0.18	0.32	6.86	0.00	0.00	0.02	0.00	-	99.674
2.p4.chrom	-	1.31	0.09	11.68	0.31	44.16	35.80	0.21	0.38	5.43	0.01	0.02	0.03	0.00	-	99.4292
2.p4.chrom	-	1.40	0.05	12.46	0.29	44.35	33.29	0.17	0.37	6.96	0.02	0.02	0.02	0.00	-	99.4111
2.p4.chrom	-	1.48	0.14	12.39	0.31	44.49	32.91	0.18	0.34	7.01	0.00	-	0.02	-	-	99.273
2.p5.chrom	-	1.39	-	11.81	0.32	44.50	34.52	0.16	0.34	6.41	-	0.01	0.02	0.00	-	99.4906
2.p5.chrom	-	1.29	0.10	11.95	0.31	44.76	34.26	0.18	0.35	6.34	0.01	-	0.02	0.00	-	99.5735
2.p5.chrom	-	1.37	0.03	11.76	0.29	44.79	34.23	0.17	0.37	6.35	-	0.01	0.01	0.00	-	99.3929
2.p5.chrom	-	1.40	0.05	11.80	0.31	44.52	34.44	0.18	0.34	6.27	0.00	0.01	0.03	0.00	-	99.3391
2.p5.chrom	-	1.26	-	12.88	0.29	44.65	32.83	0.18	0.34	6.78	0.01	-	0.02	0.00	-	99.2507
2.p5.chrom	-	1.17	0.01	13.00	0.29	44.74	33.26	0.17	0.30	6.95	0.00	-	0.02	-	-	99.9115
2.p5.chrom	-	1.11	-	13.50	0.28	44.31	33.03	0.18	0.36	7.12	-	-	0.01	-	-	99.8933
2.p5.chrom	-	1.23	-	13.60	0.25	43.62	32.98	0.19	0.38	7.22	0.01	0.03	0.01	-	-	99.5379
2.p5.chrom	-	1.22	-	12.72	0.28	45.77	32.84	0.17	0.33	6.97	0.03	-	0.02	0.00	-	100.35
2.p5.chrom	-	1.30	0.05	12.60	0.29	44.81	33.16	0.18	0.31	6.81	-	-	0.03	-	-	99.557
2.p6.chrom	-	0.82	0.02	13.93	0.27	45.07	32.00	0.17	0.33	7.02	0.01	0.01	0.02	-	-	99.6761
2.p6.chrom	-	0.70	0.16	13.85	0.22	45.35	31.56	0.13	0.36	7.21	0.01	-	0.02	-	-	99.5712
2.p6.chrom	-	0.92	0.05	14.21	0.26	44.84	32.33	0.18	0.31	7.60	0.01	-	0.01	-	-	100.718
2.p6.chrom	-	0.95	0.04	14.24	0.25	44.02	32.16	0.16	0.37	7.58	0.01	-	0.03	-	-	99.8269
2.p6.chrom	-	0.97	0.11	12.62	0.26	44.05	34.86	0.21	0.38	6.17	0.00	0.02	0.02	-	-	99.6713
2.p6.chrom	-	0.98	0.09	13.13	0.28	44.40	33.71	0.16	0.31	6.81	0.01	-	0.01	0.00	-	99.877
2.p6.chrom	-	0.93	0.08	13.30	0.28	44.57	33.83	0.16	0.35	6.63	0.02	-	0.02	-	-	100.163
2.p6.chrom	-	0.85	0.13	13.94	0.28	45.01	31.69	0.17	0.31	7.38	0.02	0.00	0.02	0.00	-	99.8242
5.p1.chrom	-	0.98	-	15.61	0.31	43.74	28.29	0.13	0.30	9.35	0.01	0.00	0.02	0.00	-	98.7423
5.p1.chrom	-	0.98	-	15.42	0.27	44.08	28.55	0.14	0.28	9.18	0.03	-	0.02	-	-	98.9424
5.p1.chrom	-	0.85	0.08	15.74	0.28	44.63	28.26	0.12	0.28	9.23	0.00	0.00	0.03	-	-	99.507
5.p1.chrom	-	1.14	0.17	14.64	0.27	45.19	29.28	0.15	0.30	8.70	0.01	0.01	0.03	0.00	-	99.8842
5.p1.chrom	-	1.13	0.15	14.56	0.28	44.30	29.65	0.18	0.32	8.96	0.00	-	0.02	-	-	99.5436
5.p1.chrom	-	1.01	0.05	14.41	0.28	44.74	29.02	0.16	0.30	8.54	0.05	0.01	0.02	-	-	98.5906
5.p1.chrom	-	0.97	0.08	15.24	0.26	44.25	29.35	0.16	0.30	8.85	0.00	0.01	0.01	-	-	99.4757
5.p1.chrom	-	1.08	-	14.14	0.32	45.17	28.72	0.12	0.30	8.99	0.05	-	0.03	-	-	98.9102
5.p1.chrom	-	1.09	0.11	14.32	0.27	44.94	28.90	0.16	0.30	9.02	-	-	0.02	0.00	-	99.125
5.p1.chrom	-	1.05	0.04	14.80	0.27	44.64	28.71	0.14	0.30	9.17	0.09	-	0.02	0.00	-	99.2249
5.p1.chrom	-	1.18	0.01	14.79	0.29	44.55	28.90	0.15	0.34	9.35	0.01	0.00	0.02	-	-	99.5955
5.p1.chrom	-	1.11	-	14.46	0.27	45.08	28.87	0.13	0.29	9.16	0.03	0.00	0.04	0.00	-	99.4421
5.p1.chrom	-	1.14	0.02	14.56	0.28	44.97	28.83	0.16	0.30	9.50	0.00	-	0.02	0.00	-	99.7947
5.p2.chrom	-	1.24	-	11.47	0.31	45.50	32.89	0.15	0.37	6.70	0.02	0.00	0.04	-	-	98.6696
5.p2.chrom	-	1.30	0.09	11.33	0.30	45.72	32.66	0.18	0.34	6.88	0.01	-	0.03	0.00	-	98.8389
5.p2.chrom	-	1.12	-	13.75	0.28	45.65	29.93	0.12	0.31	8.44	-	0.02	0.02	-	-	99.647
5.p2.chrom	-	1.05	0.03	13.61	0.25	45.61	30.09	0.14	0.32	8.04	0.01	-	0.01	-	-	99.1468
5.p4.chrom	-	1.31	-	12.53	0.30	45.20	31.70	0.15	0.32	7.36	0.01	-	0.03	0.00	-	98.9077
5.p4.chrom	-	1.13	-	12.71	0.29	45.05	32.60									

5.p4.chrom	-	1.37	0.05	12.27	0.33	45.63	32.41	0.19	0.31	7.25	0.02	0.02	0.02	-	-	99.8758
5.p5.chrom	-	1.15	-	12.86	0.28	45.20	31.23	0.16	0.36	7.45	0.02	-	0.01	0.00	-	98.7246
5.p5.chrom	-	1.01	0.05	13.36	0.27	45.84	29.71	0.15	0.27	7.83	0.02	-	0.03	-	-	98.525
5.p5.chrom	-	1.14	0.06	11.31	0.31	45.27	34.70	0.16	0.39	5.27	0.02	0.03	0.04	-	-	98.7014
5.p5.chrom	-	1.20	0.15	11.34	0.29	45.44	33.43	0.15	0.37	6.10	0.02	-	0.02	-	-	98.4984
5.p5.chrom	-	1.22	0.11	11.52	0.31	45.98	32.70	0.15	0.37	6.51	0.01	-	0.01	0.00	-	98.8703
5.p5.chrom	-	1.23	0.07	11.50	0.29	46.04	33.39	0.16	0.34	6.36	0.01	-	0.02	-	-	99.4103
5.p5.chrom	-	1.16	0.10	13.12	0.29	43.28	34.31	0.18	0.34	6.16	0.01	0.02	0.02	0.00	-	98.9784
5.p5.chrom	-	1.33	0.19	13.07	0.32	42.78	34.90	0.19	0.38	6.10	0.01	0.02	0.03	0.00	-	99.3178
5.p6.chrom	-	1.18	0.05	15.34	0.24	44.39	28.56	0.12	0.32	9.39	-	-	0.03	-	-	99.5989
5.p6.chrom	-	0.95	-	15.09	0.26	43.84	28.40	0.13	0.27	9.30	0.13	0.01	0.02	-	-	98.3906
5.p6.chrom	-	1.14	0.08	14.68	0.28	44.43	28.37	0.14	0.28	9.61	0.07	-	0.02	-	-	99.0855
5.p6.chrom	-	1.14	0.18	15.50	0.27	44.16	28.93	0.15	0.32	9.46	0.00	-	0.01	0.00	-	100.12
5.p6.chrom	-	1.16	0.08	15.18	0.29	43.77	28.83	0.13	0.31	9.30	0.01	0.01	0.02	-	-	99.103
5.p6.chrom	-	1.19	0.01	15.18	0.26	43.89	28.82	0.16	0.30	9.32	-	0.01	0.02	0.00	-	99.1633
5.p6.chrom	-	1.17	0.01	15.19	0.26	44.51	28.69	0.14	0.32	9.70	0.04	-	0.02	-	-	100.054
5.p6.chrom	-	1.00	-	15.49	0.24	43.56	28.59	0.15	0.32	9.40	0.01	-	0.02	-	-	98.7631
5.p6.chrom	-	1.14	-	15.41	0.24	44.11	28.43	0.14	0.26	9.55	0.01	-	0.02	-	-	99.3146
5.p6.chrom	-	1.17	0.04	15.38	0.26	43.53	28.75	0.15	0.27	9.39	0.01	-	0.03	0.00	-	98.9636
5.p6.chrom	-	1.05	-	15.52	0.25	44.17	28.14	0.14	0.28	9.67	0.06	0.02	0.04	0.00	-	99.3434
5.p6.chrom	-	1.03	-	15.50	0.26	44.49	28.41	0.16	0.28	9.49	0.02	0.00	0.02	0.00	-	99.6684
.p10.chrom	-	0.99	0.03	15.57	0.26	43.15	28.77	0.14	0.32	9.51	0.00	0.01	0.02	-	-	98.7652
.p10.chrom	-	1.03	0.05	15.72	0.27	43.65	28.61	0.16	0.30	9.60	0.01	-	0.03	-	-	99.4295
.p10.chrom	-	1.18	0.10	15.19	0.25	43.87	28.65	0.17	0.32	9.69	0.01	0.02	0.02	-	-	99.4779
.p10.chrom	-	1.12	-	15.16	0.27	43.32	28.77	0.14	0.27	9.44	-	0.02	0.03	-	-	98.5354
.p10.chrom	-	1.19	0.00	15.10	0.26	43.74	28.76	0.16	0.29	9.57	0.03	-	0.02	-	-	99.1249
.p10.chrom	-	1.15	0.05	15.12	0.28	43.82	28.65	0.16	0.33	9.48	0.02	0.01	0.01	0.00	-	99.0877
.p10.chrom	-	1.10	0.05	15.30	0.26	43.28	28.41	0.14	0.29	9.66	0.01	-	0.03	-	-	98.5357
.p10.chrom	-	1.22	0.01	15.05	0.28	43.83	28.95	0.18	0.29	9.57	-	-	0.02	0.00	-	99.4007
.p10.chrom	-	1.23	0.05	15.17	0.24	44.03	28.73	0.17	0.30	9.72	0.01	-	0.02	0.00	-	99.671
.p10.chrom	-	1.19	0.01	15.30	0.26	43.78	28.37	0.17	0.28	9.68	0.01	-	0.03	0.00	-	99.0659
.p10.chrom	-	1.20	0.07	15.22	0.25	43.84	28.89	0.13	0.28	9.74	0.00	-	0.02	-	-	99.6399
.p10.chrom	-	1.22	0.04	15.23	0.29	43.62	28.77	0.14	0.30	9.63	0.02	-	0.02	-	-	99.2685
.p11.chrom	-	1.13	-	16.03	0.26	43.54	28.32	0.10	0.31	9.75	-	-	0.02	0.00	-	99.4551
.p11.chrom	-	1.18	0.07	15.77	0.26	43.30	28.61	0.12	0.26	9.51	-	0.00	0.02	-	-	99.0986
.p11.chrom	-	1.17	0.12	15.48	0.26	43.67	28.28	0.16	0.29	9.74	0.01	-	0.01	0.00	-	99.1961
.p11.chrom	-	1.10	0.05	15.58	0.26	44.19	28.41	0.14	0.29	9.45	-	-	0.03	0.00	-	99.4899
.p11.chrom	-	1.14	0.03	15.59	0.28	44.45	28.10	0.12	0.27	9.68	0.00	0.01	0.01	-	-	99.7019
.p11.chrom	-	1.15	0.03	15.50	0.28	43.43	28.86	0.16	0.28	9.65	0.02	0.00	0.01	-	-	99.3631
.p11.chrom	-	1.15	0.04	15.86	0.30	43.38	28.68	0.15	0.30	9.75	0.02	-	0.01	-	-	99.6355
.p11.chrom	-	1.14	0.08	15.73	0.25	43.31	28.30	0.13	0.28	9.74	0.03	0.01	0.03	0.00	-	99.0261
.p11.chrom	-	1.17	0.10	15.13	0.26	43.84	28.27	0.13	0.33	9.70	0.02	0.00	0.03	0.00	-	99.0043
.p11.chrom	-	1.17	0.00	15.49	0.28	43.67	28.62	0.13	0.33	9.53	0.02	0.01	0.02	0.00	-	99.2735
l.p1.chrom	-	0.77	0.02	18.49	0.23	41.13	27.85	0.17	0.27	10.46	0.01	0.01	0.03	0.00	-	99.4538
l.p1.chrom	-	0.88	0.04	18.56	0.23	41.16	28.29	0.16	0.26	10.64	0.00	-	0.03	0.00	-	100.252
l.p1.chrom	-	0.75	0.10	18.46	0.22	41.05	27.52	0.20	0.26	10.53	-	-	0.03	0.00	-	99.1286
l.p1.chrom	-	0.74	0.09	18.54	0.26	40.90	28.01	0.17	0.24	10.31	0.02	-	0.02	-	-	99.2866
l.p1.chrom	-	0.81	0.08	18.34	0.23	40.73	28.53	0.19	0.29	10.39	0.01	-	0.03	-	-	99.6147
l.p1.chrom	-	0.82	-	18.51	0.23	40.97	28.24	0.18	0.30	10.36	0.03	0.00	0.04	-	-	99.6913
l.p1.chrom	-	0.71	0.01	19.14	0.27	40.71	27.58	0.16	0.29	10.04	-	-	0.02	-	-	98.9259
l.p1.chrom	-	0.71	0.04	19.00	0.26	41.30	27.22	0.13	0.27	10.34	0.01	-	0.03	-	-	99.3068
l.p1.chrom	-	0.82	0.05	18.62	0.23	41.18	27.79	0.17	0.27	10.69	0.00	-	0.03	-	-	99.8559
l.p1.chrom	-	0.82	0.13	18.66	0.24	40.99	27.79	0.18	0.25	10.32	0.02	0.02	0.01	-	-	99.4406
l.p1.chrom	-	0.79	0.00	18.89	0.24	40.55	27.37	0.20	0.27	10.77	0.01	0.00	0.02	-	-	99.1046
l.p1.chrom	-	0.80	0.06	18.95	0.24	40.93	27.93	0.17	0.29	10.57	0.00	0.01	0.02	-	-	99.9684
l.p1.chrom	-	0.80	0.03	18.82	0.26	41.06	28.13	0.18	0.27	10.31	0.01	-	0.02	-	-	99.8853
l.p1.chrom	-	0.78	-	18.70	0.26	41.02	28.05	0.19	0.29	10.32	0.01	-	0.02	-	-	99.6407
l.p2.chrom	-	0.79	0.08	18.19	0.23	41.16	28.00	0.16	0.29	10.44	0.00	0.01	0.02	-	-	99.3742
l.p2.chrom	-	0.78	0.16	18.39	0.23	41.04	28.45	0.17	0.30	10.24	0.00	-	0.02	-	-	99.7883
l.p2.chrom	-	0.80	0.03	18.82	0.26	40.35	28.09	0.18	0.29	10.48	0.02	-	0.02	-	-	99.3236
l.p2.chrom	-	0.79	0.01	18.72	0.22	40.75	28.30	0.17	0.29	10.51	0.02	0.01	0.02	-	-	99.8112
l.p2.chrom	-	0.78	0.02	18.81	0.21	40.27	27.97	0.19	0.28	10.52	0.00	-	0.02	-	-	99.0634
l.p2.chrom	-	0.79	-	18.89	0.24	40.87	27.93	0.17	0.32	10.45	0.01	-	0.02	-	-	99.6841
l.p2.chrom	-	0.77	-	18.62	0.23	40.56	28.36	0.18	0.30	10.28	0.01	-	0.03	0.00	-	99.3526
l.p2.chrom	-	0.79	-	18.57	0.21	41.04	27.78	0.18	0.28	10.40	-	-	0.02	0.00	-	99.2707
l.p2.chrom	-	0.83	-	18.79	0.23	40.66	27.86	0.17	0.31	10.63	-	-	0.02	-	-	99.5017
l.p2.chrom	-	0.77	0.11	18.71	0.20	40.13	27.59	0.17	0.26	10.66	0.01	-	0.01	-	-	98.6056
l.p2.chrom	-	0.76	-	18.29	0.22	41.31	27.41	0.19	0.31	10.58	0.00	-	0.02	-	-	99.1018
l.p2.chrom	-	0.77	0.07	18.36	0.22	41.11	27.76	0.17	0.27	10.63	0.01	0.00	0.02	0.00	-	99.4009
l.p2.chrom	-	0.79	0.12	18.78	0.24	40.57	28.00	0.17	0.30	10.36	0.00	0.00	0.02	-	-	99.3449
l.p2.chrom	-	0.81	0.16	18.74	0.23	40.20	28.49	0.18	0.28	10.11	0.01	0.01	0.02	0.00	-	99.2297
l.p2.chrom	-	0.83	0.07	18.35	0.23	40.78	28.03	0.17	0.31	10.39	-	-	0.02	0.00	-	99.1917
ijk.p3.chroi	-	0.89	0.07	14.60	0.25	44.74	29.97	0.18	0.34	8.00	0.01	0.02	0.04	0.00	-	99.0954
ijk.p3.chroi	-	0.88	0.09	14.70	0.27	44.36	30.01	0.18	0.28	8.37	0.01	-	0.02	0.00	-	99.1976
ijk.p3.chroi	-	0.94	0.06	14.22	0.26	44.04	30.95	0.20	0.30	7.85	0.01	-	0.02	0.00	-	98.8348
ijk.p3.chroi	-	0.95	0.09	14.12	0.25	44.40	30.56	0.18	0.34	8.20	0.02	-	0.01	0.00	-	99.1257
ijk.p3.chroi	-	0.96	0.12	14.51	0.25	43.64	30.26	0.16	0.34	8.17	0.05	0.02	0.02	0.00	-	98.4895
ijk.p3.chroi	-	0.99	0.07	14.68	0.24	43.27	30.70	0.17	0.31	8.27	0.01	-	0.03	0.00	-	98.733
ijk.p3.chroi	-	0.89	0.06	14.81	0.24	43.85	30.37	0.20	0.30	8.33	0.01	0.01	0.01	-	-	99.0689
chromite(c	-	0.97	0.08	14.75	0.23	43.07	30.46	0.19	0.27	8.04	0.01	0.03	0.03	0.00	-	98.1396
chromite(c	-	0.97	0.03	14.60	0.25	42.98	30.76	0.17	0.33	8.13	0.02	-	0.03	0.00	-	98.2762
chromite(c	-	0.94	0.06	14.77	0.26	43.46	30.									

jik.p4.chroi	-	0.80	0.05	17.11	0.29	41.65	29.66	0.20	0.35	8.18	0.01	-	0.03	0.00	-	98.3141
jik.p4.chroi	-	0.76	0.16	16.99	0.24	42.08	29.09	0.19	0.32	8.58	0.02	-	0.02	0.00	-	98.4488
jik.p4.chroi	-	0.86	0.07	17.08	0.26	41.61	29.47	0.19	0.29	8.55	0.01	0.00	0.03	0.00	-	98.4318
jik.p4.chroi	-	0.78	0.17	17.15	0.27	41.60	29.28	0.19	0.36	8.78	0.01	-	0.01	-	-	98.613
jik.p4.chroi	-	0.87	-	15.43	0.24	44.20	28.92	0.15	0.29	8.85	0.01	-	0.03	-	-	98.8882
jik.p4.chroi	-	0.88	0.06	15.41	0.26	44.21	28.68	0.17	0.32	8.80	0.01	-	0.01	0.00	-	98.8099
jik.p4.chroi	-	0.92	-	16.28	0.24	42.53	29.72	0.20	0.31	8.54	0.01	0.02	0.02	0.00	-	98.7918
jik.p4.chroi	-	0.90	0.11	16.59	0.25	42.22	29.88	0.21	0.32	8.42	-	-	0.02	-	-	98.9107
jik.p4.chroi	-	0.85	0.05	17.07	0.23	41.55	29.14	0.19	0.29	9.02	0.02	0.00	0.02	-	-	98.4385
jik.p4.chroi	-	0.89	0.16	17.05	0.27	42.76	29.11	0.18	0.29	9.02	-	-	0.02	-	-	99.7669
jik.p4.chroi	-	0.82	0.05	17.46	0.25	41.53	29.48	0.17	0.31	8.55	0.01	-	0.02	0.00	-	98.6391
jik.p4.chroi	-	0.81	0.04	17.57	0.24	41.83	29.00	0.17	0.30	8.66	0.01	-	0.02	0.00	-	98.6457
jik.p4.chroi	-	0.92	0.04	16.88	0.22	42.89	27.67	0.19	0.26	9.67	0.01	-	0.03	-	-	98.7716
jik.p4.chroi	-	0.95	0.09	17.03	0.21	42.98	28.11	0.17	0.30	9.45	0.02	0.00	0.03	0.00	-	99.3529
jik.p4.chroi	-	0.87	-	16.97	0.24	42.51	28.95	0.16	0.30	8.78	0.02	-	0.03	0.00	-	98.8447
jik.p4.chroi	-	0.90	0.03	17.05	0.25	41.96	29.38	0.21	0.30	8.71	0.00	-	0.03	-	-	98.8131
jik.p4.chroi	-	0.79	0.02	17.12	0.25	42.59	28.50	0.14	0.31	9.02	0.00	-	0.02	0.00	-	98.7829
jik.p4.chroi	-	0.86	0.00	16.95	0.24	43.07	28.20	0.17	0.28	9.11	0.02	0.00	0.02	0.00	-	98.9109
jik.p4.chroi	-	0.84	0.07	17.28	0.24	42.31	28.85	0.20	0.32	8.90	0.00	-	0.03	-	-	99.0296
jik.p4.chroi	-	0.85	0.03	17.18	0.22	42.49	29.15	0.21	0.30	8.89	0.01	-	0.02	-	-	99.35
jik.p4.chroi	-	0.92	-	16.03	0.24	42.71	29.03	0.19	0.30	8.97	0.01	-	0.03	-	-	98.4322
jik.p4.chroi	-	0.95	0.03	15.78	0.27	43.51	28.93	0.19	0.32	8.83	0.01	0.01	0.02	-	-	98.8529
jik.p4.chroi	-	0.83	-	17.32	0.23	42.02	28.64	0.16	0.30	9.09	0.01	-	0.03	-	-	98.6376
jik.p4.chroi	-	0.81	0.01	17.38	0.25	41.99	28.99	0.20	0.31	8.92	0.01	-	0.02	0.00	-	98.888
jik.p4.chroi	-	0.71	-	17.66	0.25	41.79	29.09	0.19	0.31	8.83	0.01	0.01	0.02	0.00	-	98.8823
jik.p5.chroi	-	0.97	0.09	15.33	0.25	43.69	29.24	0.16	0.34	8.86	-	-	0.02	-	-	98.9365
jik.p5.chroi	-	0.90	0.18	15.20	0.28	43.61	29.49	0.14	0.28	8.52	0.02	-	0.02	0.00	-	98.6311
jik.p5.chroi	-	0.89	-	15.26	0.26	43.48	29.61	0.16	0.33	8.45	0.01	-	0.03	-	-	98.468
jik.p5.chroi	-	0.90	0.00	15.08	0.27	43.81	30.08	0.18	0.33	8.44	0.02	0.01	0.02	0.00	-	99.1302
jik.p5.chroi	-	0.89	0.03	15.12	0.27	43.88	29.77	0.15	0.31	8.31	0.01	-	0.02	0.00	-	98.7703
jik.p5.chroi	-	0.87	0.12	15.35	0.26	43.84	29.54	0.18	0.30	8.45	0.00	-	0.03	-	-	98.9464
jik.p5.chroi	-	0.92	0.02	15.29	0.23	43.56	29.60	0.14	0.29	8.64	0.02	-	0.03	0.00	-	98.733
jik.p5.chroi	-	0.92	0.08	15.13	0.23	43.68	29.48	0.19	0.30	8.66	0.03	-	0.02	-	-	98.7337
jik.p5.chroi	-	0.93	0.00	15.11	0.24	43.85	29.17	0.16	0.30	8.72	-	0.00	0.01	0.00	-	98.5031
jik.p5.chroi	-	0.92	0.10	15.31	0.26	42.92	29.65	0.15	0.28	8.54	-	0.00	0.03	0.00	-	98.1451
jik.p5.chroi	-	0.88	0.02	15.31	0.28	43.79	29.10	0.17	0.28	8.81	0.03	-	0.02	-	-	98.6912
jik.p5.chroi	-	0.90	0.09	15.36	0.26	43.61	29.03	0.18	0.30	8.85	-	-	0.02	0.00	-	98.5914
jik.p5.chroi	-	0.95	0.08	15.48	0.22	43.49	29.29	0.17	0.32	8.77	0.01	0.00	0.03	-	-	98.8153
jik.p5.chroi	-	0.94	-	15.50	0.23	43.38	29.36	0.17	0.29	8.52	0.01	0.01	0.02	-	-	98.4355
jik.p5.chroi	-	0.95	0.10	15.60	0.26	43.51	29.25	0.17	0.29	8.88	0.02	-	0.02	0.00	-	99.0505
jik.p5.chroi	-	0.92	-	15.24	0.24	43.56	29.84	0.14	0.36	8.64	0.02	-	0.02	0.00	-	98.9864
jik.p6.chroi	-	0.89	0.05	16.99	0.26	42.84	28.13	0.16	0.26	9.29	0.01	-	0.03	-	-	98.911
jik.p6.chroi	-	0.91	0.02	17.22	0.25	41.84	28.02	0.17	0.31	9.36	0.00	0.01	0.03	0.00	-	98.1348
jik.p6.chroi	-	0.93	0.06	16.12	0.24	43.52	28.26	0.19	0.34	9.13	-	0.01	0.02	-	-	98.8193
jik.p6.chroi	-	0.92	0.02	16.30	0.21	43.31	28.24	0.19	0.29	9.11	0.01	0.01	0.02	-	-	98.6227
jik.p6.chroi	-	0.88	0.10	16.16	0.25	43.31	28.74	0.14	0.30	9.06	0.00	-	0.02	0.00	-	98.9765
jik.p6.chroi	-	0.90	0.10	16.46	0.23	43.47	27.90	0.15	0.30	9.18	-	-	0.02	0.00	-	98.706
jik.p6.chroi	-	0.90	0.04	16.60	0.26	43.16	28.11	0.18	0.23	9.44	-	-	0.02	-	-	98.9244
jik.p6.chroi	-	0.91	0.07	15.86	0.25	43.26	28.86	0.17	0.30	9.05	0.01	0.02	0.02	0.00	-	98.7949
jik.p6.chroi	-	0.94	0.05	16.05	0.26	42.85	29.24	0.17	0.28	9.03	-	-	0.02	-	-	98.8817
jik.p6.chroi	-	0.93	0.11	16.15	0.26	43.39	28.36	0.17	0.29	9.24	0.00	-	0.02	0.00	-	98.912
jik.p6.chroi	-	0.91	-	16.21	0.25	42.98	28.70	0.17	0.30	9.03	0.01	0.00	0.03	-	-	98.5885