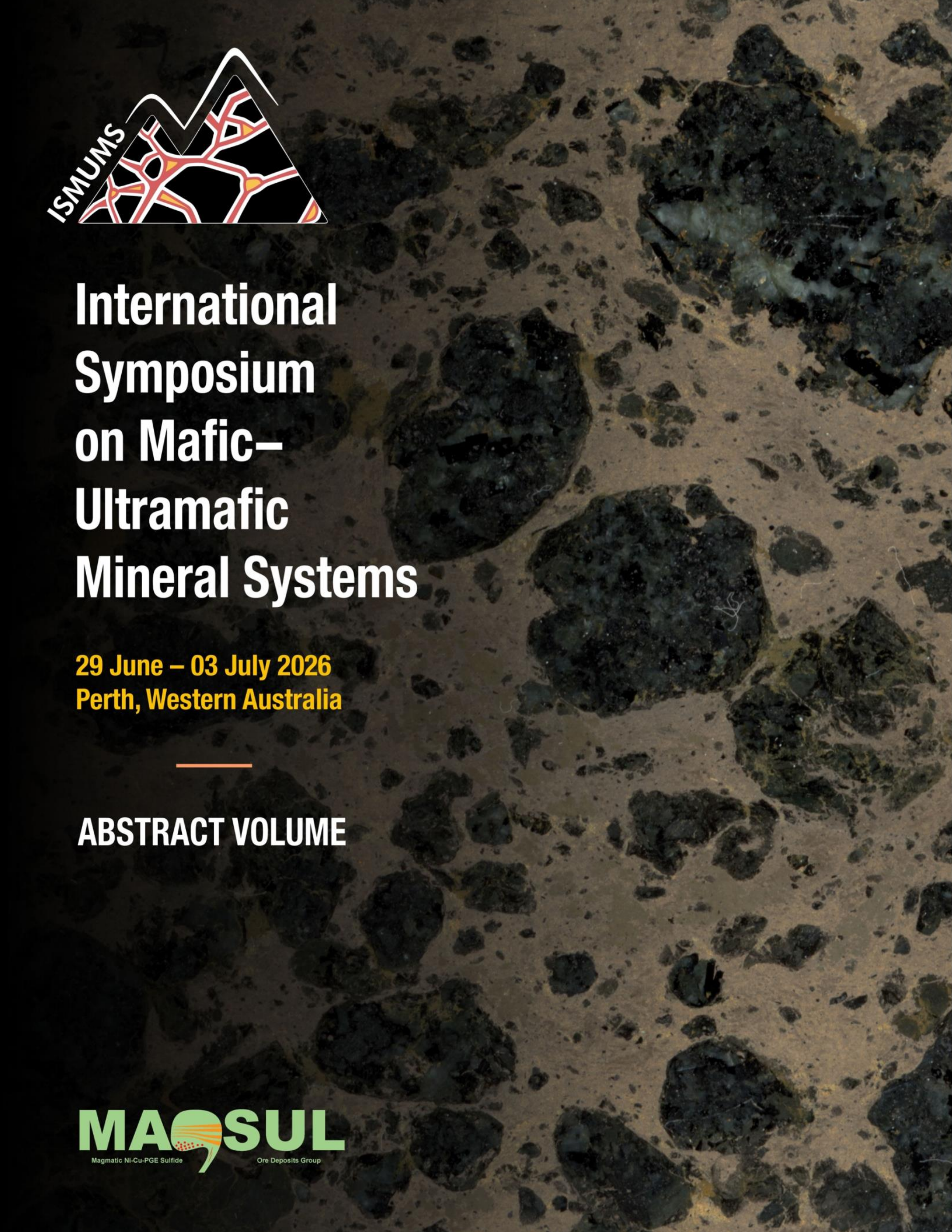

ISMUMS

International Symposium on Mafic–Ultramafic Mineral Systems

29 June – 03 July 2026
Perth, Western Australia

ABSTRACT VOLUME

MAGSUL
Magmatic Ni-Cu-PGE Sulfide Ore Deposits Group

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The International Symposium on Mafic–Ultramafic Mineral Systems 2026 (ISMUMS 2026) was held in Perth, Western Australia, from 29 June to 3 July 2026. ISMUMS 2026 continues a long-standing international conference series that began more than 50 years ago and brings together researchers, students, and industry professionals working on mafic–ultramafic magmatic systems and their associated mineral deposits. The symposium encompasses a broad range of topics related to the genesis, evolution, exploration, and sustainable development of ore systems hosted by mafic and ultramafic rocks, with particular emphasis on critical commodities including Ni, Cu, Co, platinum-group elements (PGE), Cr, V, and Ti. The conference program combines technical presentations, discussion sessions, field excursions, and workshops, providing a platform for scientific exchange and collaboration across academia, government, and industry.

This volume contains the abstracts presented at ISMUMS 2026 and reflects the diversity of current research on mafic–ultramafic mineral systems worldwide. Contributions cover fundamental and applied aspects of geology, petrology, geochemistry, mineralogy, geochronology, experimental and numerical studies, ore-forming processes, exploration methodologies, and critical mineral resources. Together, these abstracts provide a snapshot of the latest advances and emerging directions in the study of mafic–ultramafic systems and their role in supplying the mineral resources essential for modern technologies and the global energy transition. The materials of the volume are of a broad interest for geologists, earth scientists and students.

Design, editing and layout: Cherdantseva M., Schoneveld L.

Perth, Western Australia
2026

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Simulating Mafic and Ultramafic Systems – Models and Experiments

Session Convenors

Isra Ezad (University of Western Australia)
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ISMUMS
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The mineral system of komatiite-related magmatic sulfide deposits in the Central Lapland Greenstone Belt (Finland): the contribution of models and experiments

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In NE Fennoscandia, multiple events of mafic-ultramafic magmatism occurred from 2.5 Ga to 1.98 Ga in the Palaeoproterozoic rift-related basins. Three rifting phases are distinguished: a first one between 2.5 and 2.3 Ga, during the initial stage of continental breakup, which is associated with the emplacement of large layered intrusions hosting PGE mineralization (e.g. Penikat and Portimo in Finland, Fedorov-Pana in Russia); a second one between 2.3 and 2.06 Ga, characterized by the emplacement of thick basaltic lava flows and extremely rare thin intrusions; a late stage that occurred after the deposition of sulfur-bearing sediments in the rifting basin and generated small intrusions hosting conduit-type Cu-Ni-PGE sulfide deposits (e.g. Kevitsa and Sakatti in Finland, Pechenga in Russia). In the frame of the European project SEMACRET, we studied, among others, source, pathways and sink processes involved in the formation of Kevitsa and Sakatti ore deposits. Thermodynamic modelling of the komatiites associated with these deposits indicates mantle melting degrees of 15–22 %, which are significantly lower than those estimated for Archean komatiites, but still able to completely consume sulfides in the mantle source. These melting degrees were probably optimal for ensuring the maximum enrichment of sulfur and chalcophile element in the magma, as suggested by the extremely high PGE contents in many of the mafic-ultramafic lavas of the region. We estimated adiabatic magma ascent from the mantle through the lower and middle crust, minimizing the possibility of sulfide saturation before final emplacement in the upper crust. We finally examined the processes of sulfur incorporation into the magma from an external source using experimental studies at magmatic conditions. Experimental results reveal several possible mechanisms of magma-sediment interaction allowing early sulfide saturation and leading to different types of mineralization. The implications of these results are discussed in term of ore exploration at the province, camp and deposit scales.

Presentation Type:
Keynote

Constitutional zone refining in layered intrusions

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The current magmatic paradigm interprets stratigraphic sequences as direct record of liquidus crystallization onto a mostly hard floor. However, a number of sub-liquidus mechanisms can modify an original magmatic assemblage, sometimes substantially. One such process is that of constitutional zone refining. As first proposed by A. McBirney, who suggested that addition of volatiles (either due to rapid diffusion in the interstitial liquid or by upward migration of a separating fluid) into a less evolved assemblage can lead to an initially cotectic noritic assemblage of pyroxene and plagioclase (as an example) to become more pyroxene-rich over time and mimic a density-sorted profile. This is the result of both the fluid adding ferromagnesian components in preference to Al and the effect of volatiles in expanding orthopyroxene stability fields at the expense of plagioclase. Modeling suggests that very little volatile addition (<1 wt. H_2O %) to the bulk assemblage can lead to preferential melting of plagioclase, leaving orthopyroxene. The addition of low melting components SiO_2, Fe and Na (the later as chlorides) both enhance melting and limit evolution of the minerals to more primitive compositions. The local increase in interstitial liquid will also lead to more efficient compaction. Furthermore, because compaction in the overlying mush can be limited if porosity is low, interstitial melt can pond below these low-permeability assemblages. The result is the formation of an orthopyroxene-rich assemblage overlain by a liquid that will overproduce plagioclase on cooling. The result is an orthopyroxenite−norite−anorthosite sequence. With more extensive incongruent hydration melting, olivine and chromite can form by the incongruent melting of Cr-rich orthopyroxene. Overall, the liquidus to solidus regime of the crystal pile is a too-often ignored but critical part of an intrusion’s crystallization history.

Presentation Type:
Oral

Refractory sperrylite and subsolidus mobile palladium in Te–As–Bi–Sb–sulfide magmatic systems

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Platinum group minerals (PGM) are conventionally believed to crystallise from PGE-bearing sulfide liquids during magmatic system cooling. Often, these PGM deposits contain insufficient sulfide to account for total PGE abundances, a paradox often explained by sulfur loss through degassing or later oxidation or alteration. Commonly, the PGM contain Te, As, Bi, and Sb (TABS) with Pt mostly occurring as magmatic sperrylite and Pd occurring primarily with Te, Bi, and Sb. These Pd–TABS minerals occasionally occur in veins, cracks or in otherwise altered-looking postmagmatic assemblages, often with hydrothermally altered silicate assemblages. This led to the idea that Pd and TABS can be dissolved in aqueous fluids and hydrothermally mobilised. Here we show experiments containing Ni–Cu sulfides, TABS, and PGE in silicate magmas. We find immiscible sulfide and TABS–PGE liquids, with limited mutual solubility. Nevertheless, they invariably adhere to each other and to vapour bubbles. Sperrylite is an early-stage phenocryst within the TABS liquid. Slow cooling of the TABS liquid fractionates Pt, Ni, and As, with the residual liquid enriched in the low melting point elements Te, Bi, and Sb. Palladium is retained in this fluxed liquid down to temperatures below the silicate magma solidus.

Our findings explain sulfide-poor PGE deposits: if sulfide is a mechanical rather than chemical collector of PGE, then PGE abundances are not limited by their solubility in sulfide liquid. Therefore, there was no requirement for abundant sulfide in the first place. Our results also explain the late-stage appearance of Pd-TABS PGM as they remain liquid and mobile below the silicate solidus. Hydrothermal fluids circulate through the solid rock and crack it, allowing Pd migration and aiding it by flotation. Palladium mobility is not governed by its aqueous fluid solubility, but instead by its dissolution in a low-temperature TABS-dominated anhydrous liquid.

Presentation Type:
Student Oral

The boninite-like geochemistry of PGE-Ni-Cu parental magmas records anatexis and assimilation of hydrous lower crust

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Given the diversity of mafic-ultramafic cumulates through time, it is striking that the intrusions hosting PGE-Ni-Cu mineralisation have a similar, distinctive, parental melts, which have a combination of unusually high SiO_2 (52 – 56 %) contents in relation to MgO (7 – 16%), combined with low TiO_2 (0.3-0.7 %), enriched light rare-earth element patterns (REE; high λ_1) as well as depleted middle and heavy REE, leading to a U-shaped REE patterns (high λ_2; the λ coefficients describe the orthogonal polynomial function, shape components, representing the level, slope and curvature of REE patterns, following the approach of O'Neill [1]). Such melts have commonly been considered in isolation and described using a range of terms (e.g. boninite-like or having an arc-like chemical signature) to explain individual deposits. Previous investigations suggest the chemical signature of these parent melts requires the chemistry of upper-crustal lithologies to contaminate high degree melts from the asthenosphere. Here, using a series of thermodynamic forward models, we investigate an alternative process. Our results show that asthenospheric melts can both induce and assimilate anatectic melts as they migrate through a hydrous lower crust. These anatectic melts have an upper-crustal-like chemistry and when assimilated into the asthenospheric melt reproduce both the major and trace-element chemistry of the metal-rich parent magmas. We explore what geotectonic processes may cause such an interaction and investigate if the signal could be useful as geochemical tool in exploration.

[1] O'Neill, H. St. C. (2016) Journal of Petrology 57, 1463–1508. https://10.1093/petrology/egw047

Presentation Type:
Student Oral

Experimental evidence for volatiles and alkalies dissolved in sulfide melt

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The physical interaction between magmatic volatiles and sulfide melt has been recognised in natural samples, where sulfide globules are paired with caps filled by residual silicates interpreted as former vapour bubbles, such as in the Norilsk globular sulfide ore [1]. Modelling and petrological experiments attribute this close association to the strong tendency of sulfide droplets to attach to vapour bubbles and form compound droplets [2]. The formation of these compound droplets has important implications for sulfide transport, as the buoyancy of attached vapour bubbles can promote upward migration by bubble rafting, enhancing sulfide transport and deposition within magmatic systems. The chemical implications of interactions between volatiles and sulfide melt have so far been investigated in terms of metal tenor variations [3]. To expand on previous work, we conducted a series of petrological experiments examining interactions between sulfide melt and volatile-rich mafic silicate melt. Olivine gabbro from the Norilsk-1 intrusion was used as the silicate starting material, doped with variable amounts of H_2O and Cl, and equilibrated with 14 wt % synthetic FeS at 2 kbar and 1150 °C for 4 hours under near-adiabatic conditions. Experimentally produced sulfide melt blebs contain abundant, homogeneously distributed fluid inclusions. These inclusions contain variable concentrations of H_2O, Cl, and alkalies, demonstrating the capacity of sulfide melt to dissolve volatile and alkali components. Incorporation of these components is likely to modify the physical properties of sulfide melt and promote the development of chemical haloes during crystallisation. These observations further suggest that incorporation of volatiles and alkalies into sulfide melt may influence sulfide transport and metal mobility by modifying melt properties such as density, melting temperature, and interfacial behaviour.

[1] Barnes et al., 2019. https://doi.org/10.1093/petrology/egy114
[2] Mungall et al., 2015. https://doi.org/10.1038/ngeo2373
[3] Iacono-Marziano et al., 2022. https://doi.org/10.1038/s41467-022-30107-y

Presentation Type:
Oral

Laurite desulfidation during early-stage serpentinization: experimental evidence

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Under the ultra-reducing conditions of early-stage serpentinization, sulfides and alloys may react with serpentinising fluids to form secondary phases. Sulfides and alloys are the main host of platinum group elements (PGEs) in serpentinites, and extent to which serpentinisation remobilises these elements is controversial. Experiments were used to simulate early serpentinisation using cold-seal pressure vessels. A mixture of olivine, synthetic laurite, and water were reacted at 50 MPa and temperatures of 250–350 °C for durations of 1–4 days. Olivine reacts to form serpentine and brucite. Laurite breaks down to form RuSx with variable Ru:S ratios, and euhedral FeS grains. There are no systematic relationships amongst temperature, time, water content, and the composition of the Ru-phase. No neo-formed Ru-bearing phases were identified, consistent with limited Ru mobility during serpentinisation. The observed features are consistent with those of natural serpentinites that preserve the early stages of serpentinisation. Combining these results with literature reports, we suggest that Ir–group–PGE and Pd–group–PGEs may be decoupled by serpentinisation, and that serpentinisation may affect PGEs differently in different geodynamic settings, with consequences for global PGE cycling.

Presentation Type:
Oral

Silica-rich hydrous magma characteristics and three fractionation pathways of orogenic Ni-Cu deposits

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Magmatic Ni-Cu deposits in orogenic belts have become an important contributor to recent increases in global magmatic Ni resources, with deposits in the Xinjiang region of the Central Asian Orogenic Belt (CAOB) representing typical examples. These deposits are commonly characterized by orthopyroxene- and amphibole-rich assemblages, suggesting that ore-forming magmas were silica-rich and hydrous. However, the magma affinity (tholeiitic versus calc-alkaline) and evolutionary pathways of orogenic Ni-Cu systems remain to be well constrained. Here we combine MELTS modeling with high-temperature and high-pressure experimental petrology using an internally heated pressure vessel (IHPV) to investigate the differentiation of high-silica (52 wt %) and low-silica (48 wt %) basaltic magmas at 2–4 kbar and 0.5–4 wt % water. Experimental results show that high silica content is the primary control on the preferential crystallization of orthopyroxene. The appearance of orthopyroxene is strongly pressure-dependent, whereas elevated water content (>2 wt %) suppress its crystallization. In contrast, low-silica magmas preferentially crystallize plagioclase at low pressure (2 kbar) and clinopyroxene at higher pressure (4 kbar), without developing an orthopyroxene-dominated crystallization sequence under any investigated conditions. Amphibole crystallizes abundantly at temperatures below 1000 °C in both high- and low- Si experiments with moderate water contents. Importantly, the compositions of experimental glasses—representing melt evolution during Ni-Cu mineralization—exhibit both tholeiitic differentiation trends in low-silica experiments and calc-alkaline trends in high-silica experiments, a feature that cannot be directly resolved from natural samples alone. These results indicate that orogenic Ni-Cu deposits are generally associated with silica-rich and moderately hydrous magmas, rather than water-rich systems, and that some deposits may follow calc-alkaline evolutionary trends. Based on mineral crystallization sequences observed in CAOB Ni-Cu deposits, we further define three magma evolutionary pathways dominated by plagioclase, clinopyroxene, and orthopyroxene crystallization, which are consistent with IPHV experimental constraints.

Presentation Type:
Oral

Transport of sulfide and metals through dense-packing crystal mush via viscous fingering

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Cycling and transport of volatiles and metals between mantle, crust and atmosphere are crucial to planetary habitability and metallogenesis. However, the mechanisms enabling dense, metal-bearing sulfides to ascend through partially molten mantle and crystal-rich mush reservoirs remain poorly constrained. Here, through high-pressure experiments (0.5 – 1.5 GPa), 3D microtomography, and thermodynamic modeling, we show that vapour−and sulfide-saturated magmas easily generate buoyant sulfide−vapour compound drops that ascend rapidly across high-melt-fraction crystal mush, and even evolve into channel/finger-like vapour−sulfide aggregates which infiltrate low-melt-fraction (porosity, ~11−15 %) crystal mush and molten peridotite via the gas-driven viscous fingering. The μ-CT imaging further reveals interconnected melt-gas-sulfide channels that enhance the upward transport of sulfur and ore-forming elements (e.g., Cu, Ni and Au). These compound drops achieve near-equilibrium contents of ore-forming metals (e.g., Cu, Ni and Au) over remarkably short migration distances. Therefore, the long-distance, upward migration of compound drops within trans-crustal, mush-dominated reservoirs, is also accompanied by the efficient extraction and enrichment of metals into the compound drops. This upward migration efficiency is significantly amplified when upscaling to the reservoir-scale magmatic systems. We here present the experimental evidence demonstrating that gas-driven viscous fingering constitutes a viable mechanism for upward transport of dense, metal-rich sulfide liquids through the low-porosity partially molten mantle and crystal-rich reservoirs — a fundamental enigma in Earth sciences. Moreover, our findings provide an alternative mechanism for rapid vertical transfer of sulfur and metals from deep sources, facilitating the pre-enrichment of metals in magmatic-hydrothermal ore-forming systems and volcanic outgassing processes.

Presentation Type:
Oral

Control of mantle pyroxenite on the formation of Cu-Ni sulfide deposit: A thermodynamic numerical modeling perspective

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Ni- and S-rich parental magmas are the prerequisite for the formation of Cu-Ni sulfide deposit but how such magmas can be generated remains enigmatic. Here, we use a combined thermodynamic modeling and mass-balance calculation approach to depict primary melt compositions in various melting conditions like temperature, pressure, oxygen fugacity, source lithology, fluxing melting and decompression melting. The results show that Ni-rich melts can be generated when the source contain pyroxenite, while S-rich melts require low-extent (<5 %) partial melting. The aggregated decompression melts extracted from a pyroxenite-bearing sources with normal potential temperatures of ~1350 °C at 2 GPa can be highly rich in both Ni and S. At elevated mantle potential temperatures, such melts can also be generated if the final melting depths increase. Considering that arc basaltic rocks normally contain mass contribution from source pyroxenite and that Cu-Ni sulfide deposits are hosted in pyroxenite-rich intrusions, we propose that mantle pyroxenites should play a critical role in the formation of Cu-Ni sulfide deposits and the metallogenetic potentiality of mafic-ultramafic intrusions at continental margins can only be evaluated properly after the source lithology, thermal state and lithospheric thickness are understood.

Presentation Type:
Poster

Infiltration of non-wetting sulfide liquid into an unconsolidated silicate mush: Analogue models

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Understanding the behaviour of sulfide liquid within a crystal mush is fundamental to interpreting processes such as core formation in terrestrial planets, sulfide percolation leading to massive sulfide ores, and the dynamics of immiscible melt pairs documented in systems like the Skaergaard Intrusion and El Laco. Although multiphase flow is well studied in petroleum and groundwater hydrology, these insights have rarely been applied to sulfide–silicate systems, where the physical controls on liquid migration remain poorly constrained. This gap is particularly important for magmatic nickel sulfide systems: while the sources of metals and sulfur and the mechanisms of metal enrichment are comparatively well understood, the trapping and localization of sulfide liquids remain the least resolved components of the mineral system.

We present results from a suite of analogue experiments designed to investigate the infiltration, coalescence, and transport of dense sulfide liquid analogues within an unconsolidated silicate crystal mush. Using high-resolution X-ray computed tomography (CT), we quantify the geometry and dynamics of liquid migration and identify the conditions under which sulfide liquids transition from trapped droplets to mobile, interconnected networks. Our experiments show that: (1) very small droplets, smaller than the pore size, tend to become stranded; (2) variations in wetting behaviour between sulfide liquid and silicate crystals — linked to oxidation state or mush composition — strongly influence infiltration; and (3) sulfide liquid mobility depends on liquid proportion, with a critical threshold of ~10–15 wt % required for efficient percolation. Below this threshold, droplets coalesce but remain immobile, whereas higher proportions lead to rapid infiltration and even localized fracturing of the crystal framework. These behaviours reflect the shifting balance between gravitational and interfacial tension forces.

Presentation Type:
Oral

Thermodynamic modelling of mafic-ultramafic systems: A new workflow

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Thermodynamic forward modelling is widely applied to mafic-ultramafic systems to explore crystallisation, contamination and magma mixing. In practice, however, many applications remain a form of circular validation: a putative parent melt is inferred — often through extensive trial and error — from the same geochemical trends the model is then tuned to reproduce. Plutonic mafic–ultramafic cumulates add further complexity because they are mixtures of multiple solid phases and variable amounts of trapped liquid; they do not correspond to naturally-occurring melt compositions. Further, reaction between primocrysts and trapped liquid can overprint primary mineral compositions in a process called trapped liquid shift (TLS). These factors commonly force modellers into intensive manual parameter sweeps, where the number of required runs grows rapidly as additional variables (e.g., pressure, fO_2, H_2O) are explored.

We present a workflow that couples Monte Carlo-style thermodynamic modelling to automated matching by least-squares minimization. Using the MAGEMin engine accessed via the PetThermoTools wrapper, we generate hundreds of forward models per batch while varying starting composition, crustal contribution, fO_2, pressure and H_2O. Each run produces model liquid and solid compositions and physical properties, phase assemblages, and mineral compositions. These outputs are then used as inputs for sulfide liquid saturation models and corresponding Pt–Fe alloy solubility models, to indicate when Pt-alloy and sulfide saturation occur and how liquid Pd/Pt values evolve during differentiation.

To connect models to observations, we implement weighted least squares “matchers” that (i) identify best-fit model iterations for a target liquid composition and (ii) iteratively mix model solids + liquids to reproduce natural cumulates. This provides best fit solutions and indicates a likelihood of whether ‘Magma A’ can evolve into ‘Magma B’ or produce ‘Cumulate A’, and under what conditions. Finally, we integrate updated TLS simulations that resample model mineral–liquid pairs to quantify postcumulus modification of olivine and orthopyroxene compositions.

Presentation Type:
Poster

Novel Analytical and Exploration Approaches

<u>Session Convenors</u>

Louise Schoneveld (CSIRO)
Stephan Thiel (CSIRO)

Muon tomography: Advancing resource confidence and geotechnical insight in mafic–ultramafic mineral systems

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Mafic–ultramafic intrusions host critical Ni–Cu–Co–PGE resources, yet their complex geometry and depth create challenges for both resource delineation and geotechnical stability. Conventional drilling and traditional geophysical methods struggle to deliver high-resolution subsurface intelligence at scale, without significant costs and risks.
Muon tomography introduces a novel, non-invasive approach to imaging density variations at deposit scale. By harnessing naturally occurring cosmic-ray muons, this technology generates true 3D density models across billions of cubic meters with meter-scale resolution, without additional drilling. It complements gravity and seismic data and integrates seamlessly with existing drillhole information, expanding its spatial coverage and enhancing interpretation beyond the limits of point-based drilling data. This synergy enables geoscientists to refine geological models, validate targets, and optimize mine planning.

This paper highlights three applications:

- Resource confidence: At BHP Nickel West's Cliffs and Leinster operations in Western Australia, muon tomography imaged komatiite-hosted massive sulfide systems over 1.5 billion m^3, improving geological models and reducing exploration cost
- Geotechnical insight: At Vale Base Metals' Creighton Mine in Sudbury, Canada, muon tomography mapped voids and remnant mineralization, informing ground control strategies and mine stability
- Near-mine extension: At Vale Base Metals' Totten Mine in Sudbury, Canada, muon tomography supported identification of potential extensions beyond current workings, enhancing resource confidence and planning.

Muon tomography aligns with ISMUMS2026's theme of "Novel Analytical and Exploration Approaches" and offers a transformative tool for advancing both resource confidence and geotechnical decision-making in mafic–ultramafic systems.

Presentation Type:
Invited Oral

Understanding mafic–ultramafic systems in Australia through multi-geophysical imaging

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The Australian continent has been modified by large-scale mafic–ultramafic magmatic events through time. These magmatic processes have altered the structure and composition of the crust and mantle, which can be imaged using geophysical data. Benefiting from the national-scale MT deployment (AusLAMP and WA-MT) and recent advances in joint inversion frameworks, we present a joint MT–gravity product across the Australian continent, using variation of information as a constraint. Several models were generated with different coupling weights to assess model variability. These models resolve sharper conductive bodies and more closely coupled density–resistivity structures.

Based on the inversion results, we can delineate different mantle domains in Australia. High-density conductors indicate sulfide, graphite, or dry melt, while low-density conductors point to fluids or melt. Using PIDE (Petrophysical Interpretation tools for geoDynamic Exploration), we remove thermal and compositional impacts on resistivity to quantify the metasomatic state of the mantle. We also investigate the footprint of these mafic-ultramafic system, and understand the processes involved in forming critical commodities.

Presentation Type:
Oral

Magmatic Ni-Cu mineral system footprints: crustal insights from joint magnetotelluric and gravity data in southern Australia

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Mineral exploration requires an understanding of mineral system footprints at scale to increase discovery rates. A key step in greenfield exploration is a regional appraisal of mineral prospectivity, which should consider not only on the broader regional geology, but also the vertical signatures of mineral systems that extend downward into the crust. Here, we present magnetotelluric (MT) data across a 12.5 km array and two closely spaced profiles totaling over 300 new broadband MT stations, across the western margin of the Gawler Craton, South Australia. The area is prospective for magmatic Ni-Cu sulfide mineralization hosted in mafic-ultramafic rocks, exemplified by the Aristarchus prospect. These data reduce the 50 km site spacing from the existing AusLAMP (Australian Lithospheric Architecture Magnetotelluric Project) by a factor of four, improving the resolution of the resistivity structure from the lower to upper crust. This helps bridge the gap between regional context and camp-scale mineral system targeting, providing a key link between isotopic data and traditional geophysical targeting techniques. Additionally, closely spaced gravity data every 1-2 km were acquired by the Geological Survey of South Australia. Together, these datasets reveal new crustal-scale maps of density and resistivity. We have delineated a crustal-scale mineral system footprint that is consistent with the existence of high-degree partial melts, known to be favorable for magmatic sulphide mineralization. Notably, a coincident density high and very resistive middle to upper crust is suggestive of a depleted and refractory residue that has been linked to melting during the Sleafordian Orogeny. By combining geophysical observations with forward models of ore-forming processes and their expected petrophysical signatures, we can test which magmatic scenarios could have plausibly generated the observed resistive and dense domains, thereby strengthening the link between regional geophysics, camp-scale targeting, and mineral system evolution.

Presentation Type:
Oral

Reconsidering the effective graphical presentation of PGE data for mineral exploration

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Traditionally the construction of normalized elemental histograms, developed principally for the effective presentation of trace elements (e.g., Thompson et al., 1983), has been based on a philosophy of both selecting a reservoir that has some direct petrological relevance to the rocks being plotted, and also based on a geochemical logic that ideally varies systematically from one side of the plot to the other. Examples of such plots include the particularly specialized rare earth element (REE) plot, and trace element spidergrams.

The platinum group elements (PGE), consisting of six elements across two rows (5-6) and three columns (VIIIA) in the Periodic Table, are less easily systematically positioned for plotting. In lithological systems they are controlled by their strongly siderophile, and specifically chalcophile partitioning behaviour. The conventional PGE plot includes the six PGE plus Au, normalized to primitive mantle, and plotted in order of descending melting temperature [1]. It has been common practice to supplement the PGE+Au with other associated metals, specifically Ni and Cu, positioned accordingly to sulphide compatibility criteria, and not melting temperature. An assessment of variants of these plots in which other metals of economic interest are included, such as (the non-chalcophile siderophile elements) V, Cr and Co. Figure 1 shows plots based on a) melting points, b) partitioning of the element between monosulphide solid solution (sulphide solid) and sulphide liquid, and finally c) a compromise based on empirical criteria. An outcome of some of these plots is that Rh plots with the IPGE rather than with the PPGE, with whom it is notionally associated.

[1] Barnes, S.-J, Naldrett, A.J. & Gorton, M.P. (1985) Chem. Geol. 53, 303–323.

Presentation Type:
Oral

Terrane-scale tectonic alignment of suites of giant, Archean layered intrusions in the western Yilgarn Craton, Western Australia

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Voluminous mafic–ultramafic magmatism dominates much of the Archean rock record of the Yilgarn Craton in Western Australia. In the west (the Youanmi, Narryer and South West Terranes) intrusive mafic–ultramafic rocks form up to 40 % of greenstones. Recent mapping, integrated with geochronology, geochemistry and geophysical data, allows categorization of these intrusions in into six suites, intruded at 3.05, 2.81, 2.80, 2.79, 2.72 and 2.67 Ga. Isotopic work has characterized the nature and extent of mantle vs crustal input into these magmas and helps to determine which mafic volcanic units are associated with these suites, and their geodynamic context. Platinum Group Element (PGE) analyses from drillcore are used to identify different magma pathway processes operating in several of these suites. Key Cr–Cu–Ni–PGE and V–Ti–Fe mineralized sections have been placed into context within cumulate stratigraphy in several intrusions. Together, the array of mafic–ultramafic layered intrusions of the western Yilgarn Craton provide key markers in the crustal development of the craton and align with and help to define axial zones of variably metasomatized, juvenile addition from mantle to crust. Thus, we form an initial framework for the understanding of intrusive orthomagmatic mineral systems during the Meso- to Neoarchean development of the Yilgarn Craton.

Presentation Type:
Oral

A combined compositional and Cu-isotope study of gold mineralization from carbonatites and placer deposits of the Guli massif (Polar Siberia)

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Complex gold-iridium-osmium placer deposits, associated with the Guli massif of ultramafic, alkaline rocks and carbonatites, are located within the Maimecha−Kotui province, northern part of the Siberian Craton. Unlike platinum-group element mineralization, which is genetically linked to ultramafic rocks, the question of the bedrock source of gold mineralization remains controversial. To address this issue, we evaluated the mineral assemblages, chemical and Cu-isotope composition of native gold from calcite-dolomite carbonatites of the Southern carbonatite stock and Quaternary sediments of the Gule and Dunitovaya Rivers, located in close proximity to the carbonatites of the Guli massif. The analytical study was performed at IGG UB RAS using scanning electron microscopy, electron microprobe analysis, and Cu-isotope analysis, the latter detailed in [1]. The analyzed gold grains from calcite-dolomite carbonatites and placer deposits of the Guli massif are represented by monophase crystals and polyphase mineral assemblages, which consist of high-fineness gold, natural Au-Ag-(Cu) alloys, tetra-auricupride and auricupride, the latter often characterized by exsolution textures formed in the temperature range of 550-240 °C. Bedrock and placer gold grains contain euhedral single- and polyphase sulfide inclusions, which are represented by pentlandite, troilite, chalcopyrite and galena. The Cu-isotope data for gold grains from calcite-dolomite carbonatites and placer deposits of the Guli massif revealed identical, within uncertainty, average δ^{65}Cu values (-0.49 ± 0.08 ‰ (n=3) and -0.30 ± 0.27 ‰ (n=13), respectively), indicating their origin from a juvenile source. The identified similarity of mineral assemblages, chemistry and Cu-isotope data for native gold from calcite-dolomite carbonatites to that from placer deposits of the Guli massif provide evidence that the detrital gold grains were derived from carbonatite series rocks, implying that derivatives of ijolite-carbonatite magmatism played a significant role in the formation of gold deposits.

This study was supported by the Russian Science Foundation (project No. 25-17-00116).

[1] Okuneva T.G. et al. (2022) Geodynamycs & Tectonophysics. 13 (2s). 0615.

Presentation Type:
Poster

Precompetitive geophysical datasets for improved ore body detection

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Magnetic surveys are among the most widely used geophysical methods in mineral exploration, providing critical information for detecting and delineating subsurface structures and ore-bearing systems. As near-surface, high-grade deposits become increasingly rare, exploration is shifting toward deeper targets and more complex geological settings, with innovative technologies driving new discoveries. High-quality, openly accessible geophysical datasets are essential in this context, providing baseline information that reduces risk, supports target prioritization, and enables companies to adopt new methods with confidence. Such datasets allow researchers and industry to benchmark techniques, test workflows, foster collaboration, and support training in complex geological settings.

Full tensor magnetic gradiometry (FTMG) is an emerging technology that measures all components of the magnetic field gradient tensor, providing enhanced imaging of subtle geological structures and ore bodies. When deployed with highly sensitive quantum sensors such as Superconducting Quantum Interference Devices (SQUID), FTMG can detect low-amplitude anomalies and fine-scale features that conventional total magnetic intensity (TMI) surveys often can’t resolve. Compared to TMI, FTMG offers improved spatial resolution, directional information, and reduced influence from regional magnetic fields, diurnal variations, and cultural noise, making it a powerful tool for detailed interpretation and 3D inversion modelling.

Despite these advantages, adoption of FTMG has been limited by logistical complexity, depth constraints, and a lack of publicly available datasets, especially in geologically complex or remanently magnetized areas. To address this, the Geological Survey of Canada is acquiring and openly disseminating precompetitive FTMG datasets. These datasets provide real-world data for benchmarking methods, testing inversion workflows, and evaluating emerging quantum sensors. By increasing accessibility, this initiative fosters innovation and supports next-generation exploration technologies.

Presentation Type:
Poster

Matrix-matched sulfide reference materials for high-precision LA-ICP-MS trace element analysis

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Accurate trace element analysis of sulfides by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) requires matrix-matched calibration reference material (RM) to account for systematic errors introduced by matrix-dependent differences in ablation yield, aerosol transport efficiency, and ionization processes. This study presents a protocol for synthesizing in-house RMs that replicate the matrices of the most commonly LA-ICP-MS-analyzed natural sulfide minerals. The study aims to achieve homogeneous distribution of trace elements in these matrices at different concentrations (1, 10, and 100 ppm). Such an approach enables reliable multi-point calibration, improving quantification accuracy and lowering detection limits. The synthesis involves introducing trace elements (as chalcogenides) into a sulfide matrix powder during mechanical homogenization in a planetary ball mill. Key optimization parameters include rotation speed, milling duration, and the use of a liquid medium (e.g., acetone) to prevent oxidation. The homogenized powder is pressed into pellets and annealed at 600 °C to ensure final consolidation and chemical homogeneity. The developed protocol allows for the synthesis of a pyrrhotite-based RM with relative standard deviations (RSD) below 5 % for 27 trace elements (including six platinum-group elements) at laser parameters: 50 µm beam diameter, 7 µm/sec scanning speed, 10 Hz repetition rate. The methodology is successfully adapted to other major sulfide matrices. Future work includes validation of the RMs using solution-based ICP-MS and inter-laboratory comparison.

Presentation Type:
Poster

Magmatic Processes

Session Convenors

Will Smith (CSIRO)
David Holwell (University of Leicester)
Maria Cherdantseva (University of Western Australia)
Wolf Maier (Cardiff University)
Sarah Dare (University of Quebec at Chicoutimi)

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Mechanisms and conditions for PGE enrichment in porphyry deposits

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Platinum group elements (PGEs), particularly palladium (Pd) and platinum (Pt), represent valuable by-products in porphyry Cu–Au systems. Despite their economic importance, the magmatic and hydrothermal processes responsible for PGE enrichment in porphyry deposits remain incompletely understood. This study summarizes current knowledge regarding the key mechanisms that control PGE enrichment in porphyry systems.

PGE-enriched porphyry deposits are commonly associated with highly oxidized, alkalic magmas generated in subduction to post-subduction tectonic environments. Elevated oxygen fugacity delays sulfide saturation, preventing early sequestration of PGEs in the lower crust. Under these conditions, Au and Pd behave as incompatible elements in silicate melts, while Pt and iridium-group PGEs are preferentially partitioned into early-formed Pt alloys or Cr-spinels. Shallow crustal differentiation at depths of approximately 20–30 km, particularly in thin crust or extensional settings within thick crust, may further delay sulfide saturation because sulfur solubility increases as pressure decreases.

As magma ascends into shallow reservoirs, sulfide segregation coupled with volatile saturation can enhance metal partitioning into vapor phases, promoting efficient transfer of PGEs into magmatic-hydrothermal fluids through sulfide liquid–vapor bubble interactions. In post-subduction environments, remelting of subduction-modified, sulfide-bearing hydrous lithosphere has also been proposed as a source of PGE-enriched primary magmas.

Hydrothermal enrichment of PGEs is favored by high temperatures (>600 °C) and hypersaline brines (>60 wt % NaCl). Primary Pd and Pt precipitation typically occurs during the hypogene stage, where these elements are incorporated as solid solutions within early Ni- and Co-rich pyrite prior to major copper mineralization. Cooling of orthomagmatic fluids transporting PGEs as chloride complexes drives this co-precipitation process. In some post-subduction systems, semimetal melts enriched in Bi and Te may act as collectors, scavenging PGEs from hydrothermal fluids and facilitating localized enrichment independent of sulfide precipitation. Together, these processes highlight the importance of oxidized magma sources, delayed sulfide saturation, and specialized hydrothermal conditions in promoting PGE enrichment in porphyry systems.

Presentation Type:
Keynote

Magnetite-hosted Cu-PGE and Fe-sulfide mineralization in 1078 Ma layered mafic intrusions in the west Musgraves region of Western Australia

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Magnetite related Cu–PGE mineralisation occurs in several prospects developed in the most evolved upper parts of the 1078 Ma Giles Complex intrusions, Musgrave Province, Western Australia. This study examines the Jameson and Cronus prospects in the Mantamaru Intrusion and the Navigator prospect south of the Blackstone Range Intrusion. The intrusions comprise leucogabbronorite, gabbro/gabbronorite, hornblende gabbro and troctolite. All prospects host low grade Cu–PGE mineralisation closely associated with titaniferous magnetite, but differ markedly in thickness, sulphide assemblage, geochemical signature, magnetite abundance and metal tenor. Jameson mineralisation is linked to a 2–5 m magnetitite, comparable to the Stella intrusion, whereas Navigator mineralisation occurs within >70 m of magnetite bearing gabbronorite, similar to the Rio Jacaré intrusion. Both are reef type systems. Cronus, however, appears unique, with ~310 m of mineralised hornblende ± biotite gabbro lacking any repetition.

At Jameson and Navigator, Cu, Au, Pt, Pd and S are extremely low below the first appearance of magnetite, but increase sharply with the first appearance of sulphide, coincident with elevated $Fe_2O_3+TiO_2+V_2O_5$. Copper reaches 0.42 wt % and Pt+Pd+Au up to 2 ppm, with S rarely >0.4 wt %. Sulphides (<1 modal%) are dominated by bornite and chalcopyrite. Pt–Pd peaks are typically offset from Cu–Au. High Cu/Ni and low S/Se ratios indicate Ni partitioning into silicates prior to sulphide saturation and minimal crustal contamination.

At Cronus, most magnetite rich gabbro contains low grade (~0.11 % Cu) bornite mineralisation. Pt–Pd–Au is largely restricted to intrusion margins, consistent with cooling from both top and base. Geochemical data show Cronus represents an extreme fractionated end member with lowest Mg# and highest incompatible element concentrations.

Jameson and Navigator mineralisation reflects late stage, magnetite driven sulphur saturation in highly fractionated, uncontaminated mafic magmas. Cronus likely formed from a residual hydrous magma accumulating in the upper chamber during waning magma supply, with no significant recharge to dilute increasing volatile contents.

Presentation Type:
Keynote

An assessment of chonolith emplacement mechanisms

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The structure of many irregularly shaped, mineralised intrusions (chonoliths) cannot be explained by classical magma emplacement mechanisms such as ductile-viscous diapirism, brittle stoping or elasto-plastic sheet propagation (i.e., dykes and sills). The geometries of such mineralised intrusions vary widely from tube or finger like bodies (e.g., Current Lake, Uitkomst, Nebo-Babel), elongate sills (e.g., Norilsk), stair-stepping dyke-sill systems (e.g., Voisey's Bay), bladed dykes (e.g., Méquillon, Savanna), funnels (e.g., Kalatonge) and complex dyke-like bodies (e.g., Tamarack, Eagle).
Several factors that may explain these types of intrusion geometries and related ore-trapping structures: 1) the role of host-rock structures during magma sheet propagation; 2) emergence of lobe and finger-like structures at the margins of magma sheets; and 3) host-rock brecciation, thermal-mechanical erosion and contact melting. For example, the Ovoid and Discovery Hill Dyke at Voisey's Bay formed by interaction between host rock anisotropies and a propagating magma sheet. However, enlargement of mineralised segments requires the operation of a second mechanism such as thermal-mechanical erosion. Secondly, finger-like structures are frequently observed at the margins of natural and experimental sills. Although elongated fingers are seen to emerge from some sill margins in nature they have yet to be replicated experimentally. The progression from short magma fingers to long tubes such as Current Lake and Uitkomst requires the operation of an additional mechanism such as brecciation, contact melting or fluidisation to drive runaway elongation. Lastly, dyke-like intrusions such as Eagle have highly mineralised tubular to anvil shaped segments in long section, which cannot be explained by conventional magma sheet propagation mechanisms. The association of Eagle with marginal host-rock breccias and extensive carbonate alteration suggests that potentially explosive, volatile-driven fragmentation occurred just before or during magma emplacement. The resulting geometries are consistent with field and analogue experimental observations of breccia dykes/pipes and explosive volcanic vents, respectively.

Presentation Type:
Oral

Mottled anorthosites and discordant ultramafic bodies in the Critical Zone of the Bushveld Complex: genetic links or parallel evolution?

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Mottled anorthosite is abundant in the Critical Zone of the Bushveld Complex and contains mottles, aggregates of ortho- and clinopyroxene oikocrysts with hornblende, sometimes with olivine and mica. At Tweefontein (eastern Bushveld), a ca. 25 m thick river outcrops between the MG4 and UG1 intervals exposes feldspathic pyroxenite, norite and mottled anorthosite cut by synplutonic discordant ultramafic bodies (Iron-Rich Ultramafic Pegmatites, IRUPs), mainly clinopyroxenite with minor orthopyroxenites/websterites. Contacts with norite and anorthosite are wavy and irregular, one orthopyroxenite shows pegmatitic crescumulate textures, and locally the bodies grade into mottles. Mottles and discordant bodies share assemblages and phase compositions: clinopyroxene contains relict orthopyroxene cores and amphibole rims; pyroxene and amphibole compositions are similar. Clinopyroxenites are REE rich with fractionated M to HREE and a pronounced negative Eu anomaly, indicating previous precipitation of plagioclase, whereas orthopyroxenites are REE poor with flat to weakly fractionated HREE and weak to absent Eu anomalies.

Initial $^{87}Sr/^{86}Sr$ ranges from 0.7050 to 0.7083 (n = 13) and εNd at 2054 Ma from –8.9 to –4.8 (n = 9). Anorthosites match typical values for the lower to upper Critical Zone transition, while discordant bodies fall at higher Sri values typical of the Critical Zone to Main Zone transition (e.g., Merensky Reef). To test whether mottles can form from trapped intercumulus liquid, we ran two-stage MAGEMin models: fractional crystallisation to obtain evolving melt compositions, then equilibrium reaction between melt and a plagioclase plus orthopyroxene mush. Across a melt rock ratio grid, the stable assemblage and the compositions of pyroxenes are controlled mainly by melt/mush ratio, supporting mottle formation by crystallisation of trapped liquids within a plagioclase and orthopyroxene framework. Mottles can therefore be treated as small scale closed system analogues of the discordant ultramafic bodies and used to constrain late stage melt crystal separation in the Bushveld Complex.

Presentation Type:
Oral

Enigmatic copper-rich magmatic sulfide mineralization at Okiep, South Africa

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Demand for copper resources has led to new exploration activity in the Okiep copper district, Northern Cape, South Africa. The Okiep deposits are hosted in the 1060−1030 Ma Koperberg suite (KS), which intruded largely granite-gneiss country rock in the western part of the Namaqua-Natal terrane. The KS comprises mica-apatite-bearing norites enriched in L/HREE, Th, with high initial $^{87}Sr/^{86}Sr$ and low ϵNd. KS magmas were emplaced syn-tectonically into E-W-trending antiformal discontinuous cusp-like structures related to folding during granulite metamorphism. The sulfide ores are compared to typical magmatic sulfide systems; however, a unified metallogenic model for Okiep is precluded by their unusual geology. New drillcore provides fresh insight into Okiep metallogenesis. Copper ores are broadly divided into two categories: Narrap (po-ccp-pn) and Carolusberg (ccp-bn-mgt). Narrap ore is reminiscent of MSS assemblages in typical magmatic Ni-rich sulfide deposits, whereas Carolusberg ore is atypical. Narrap and Carolusberg ores form disseminated, net-textured and semi-massive segregations in norite. At Nous, in the western parts of the district, Narrap and Carolusberg ores occur together. Apatite inclusions in sulfide are common, suggesting a possible role for immiscible P-rich melts. Local fracture-hosted sulfide ores in some deposits suggest late-copper remobilization. ICPMS geochemistry and TIMA element maps reveal significant quantities of monazite and zircon in KS norite. Polygonal (recrystallized) textures are common and are indicative of solid-state deformation during granulite metamorphism. Abundant zircon-monazite, along with strongly enriched bulk rock compositions, is consistent with crustal assimilation during emplacement of KS magmas. Coexisting Narrap and Carolusberg ores, along with re-equilibrated mineral textures, suggest metamorphic oxidation locally upgraded copper grades. A holistic petrogenetic model for the KS will need to explain local evidence of metamorphic oxidation of ores, and its wider distribution across the Namaqua-Natal terrane, including the Steenkampskraal monazite mine and the Kliprand nickel deposits.

Presentation Type:
Oral

Nature of the Lower Critical - Upper Critical Zone transition in the Clapham Trough area, Eastern Bushveld Complex: Evidence for the introduction of crustal fluids in response to plagioclase stabilisation?

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The boundary between the Lower Critical Zone (LCZ) and Upper Critical Zone (UCZ) of the Rustenburg Layered Suite marks a major stratigraphic transition throughout the intrusion, characterized by a shift from intercumulus plagioclase in the LCZ to cumulus plagioclase in the UCZ. The nature of this boundary remains debated. Some researchers argue that plagioclase attains cumulus status through continued fractionation of the resident magma, whereas others propose that the transition reflects the addition of compositionally distinct magma(s).

In this study, we present in-situ Sr-isotope analyses on plagioclase, together with whole-rock major and trace element geochemistry and mineral chemical data across the LCZ–UCZ boundary intersected by borehole BH6958 on Forest Hill farm in the eastern Bushveld Complex. Major and trace element systematics (e.g., Cr contents in orthopyroxene) support the interpretation that no new, compositionally distinct magma was introduced at this level of the intrusion. However, Sr- and Nd-isotope data point to open-system behaviour.

The observed isotopic excursion cannot be reproduced by mixing between the resident B1 magma and other proposed parental magmas (e.g., B2 or B3). Instead, modelling suggests that the isotopic shift could result from limited mixing between the resident magma and lower-crustal melts, although it remains uncertain whether such mixing triggered the stabilization of plagioclase. An alternative explanation is mixing between the B1 magma and small amounts of crustal fluids. In this scenario, fluid ingress appears to have been gradual, with initial $^{87}Sr/^{86}Sr$ in plagioclase increasing from core to rim in the LCZ and reaching even higher values in the lower UCZ.

Based on thermodynamic modelling, we propose that once plagioclase began to crystallize, the system contracted more rapidly than before plagioclase saturation. Fluids from the surrounding hydrothermal system may have entered the magma chamber to compensate for the volume loss associated with cooling.

Presentation Type:
Oral

Evaluating the potential for magmatic sulfide mineralization in the Bradley Peak komatiitic basalt lava flows, Wyoming Province

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Precambrian komatiitic greenstone belts are fundamental to understanding early Earth evolution and can be important hosts of sulfide deposits containing economic concentrations of nickel. Here, we characterize spinifex- and cumulate-textured komatiitic volcanic rocks from the 2.7 Ga Bradley Peak greenstone terrane in the Wyoming Province, United States to assess their mineralization potential. The komatiitic lava flows are characterized as spinifex-textured rocks containing acicular parallel- or random-oriented pyroxene needles, replaced by actinolite, and serpentinized olivine cumulates with minor chromite. Based on whole-rock major element geochemistry, spinifex-textured samples are classified as Al-undepleted komatiitic basalts (11-17 wt % MgO). Initial εNd values of −0.5 to +4.7 indicate that these lavas were derived from a depleted mantle source and did not assimilate substantial amounts of evolved crust, which is typically crucial to provide sulfur for sulfide deposits. Rare earth element geochemistry and thermodynamic modeling suggest these magmas assimilated rocks from banded-iron formation units, observed to be in contact with the volcanic flows; however, these units lack the sulfur that would be required for sulfide mineralization. Komatiite-hosted sulfide deposits are commonly associated with high-degree partial melting of the mantle, whereas the primary magma to Bradley Peak komatiitic basalt flows is estimated to have had 19 wt % MgO and to be derived from relatively low-degree partial melting — 15 to 25 % at 3–4 GPa. Concentrations of PGEs in komatiitic basalts and olivine cumulates as well as Pd/Ti, Rh/Ti, and Pt/Ti ratios do not contain positive evidence for sulfide mineralization. The combined data indicate that Bradley Peak komatiitic basalts do not satisfy key criteria for magmatic sulfide deposits due to their lack of assimilation of a crustal sulfur source, derivation from relatively low-degree mantle partial melting, and barren trends for PGE/Ti ratios.

Presentation Type:
Oral

Nickel, cobalt, and manganese distributions in olivine and orthopyroxene as indicators of sulfide-rich mafic-ultramafic systems: a case study from the Nova-Bollinger Ni-Cu-Co Deposit in Western Australia

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Compositional variations in olivine and orthopyroxene from the Nova-Bollinger Ni–Cu–Co deposit (Western Australia) were examined to assess how mineral chemistry relates to orebody proximity and to expand their utility as indicators of magmatic sulfide prospectivity. The Nova-Bollinger deposit comprises a mineralised Lower Intrusion (LI) and a comparatively barren Upper Intrusion (UI), each containing mafic to ultramafic mesocumulates and orthocumulates. In the UI and sulfide-poor intervals of the LI, olivine and orthopyroxene compositions are consistent with fractional crystallisation and variable degrees of sulfide-absent and sulfide-present trapped liquid shift (TLS). Positive intra-sample Ni–Co correlations persist in ferromagnesian silicates not significantly associated with sulfides, which can arise from TLS and should be examined with respect to an appropriate baseline. By contrast, olivine and orthopyroxene in sulfide-rich intervals of the LI display anomalously low Co and high Mn concentrations for given molar Mg contents, producing elevated Ni/Co ratios that cannot be explained by fractional crystallisation or TLS. Trace element mapping reveals local Co, and to a lesser extent Ni, depletion in olivine adjacent to sulfides. Re-examination of pentlandite chemistry at Nova-Bollinger shows that disseminated pentlandite is enriched in Co, and less so Ni, relative to pentlandite in massive sulfides. It is proposed that ferromagnesian minerals are preferentially stripped of Co during re-equilibration with high-temperature pentlandite, leading to slight postcumulus upgrading of Co tenors in net-textured ores. New discrimination diagrams and TLS parameterisations are presented to help interpret ferromagnesian silicate chemistry by distinguishing the effects of fractional crystallisation, TLS, and sulfide interaction. Although olivine and orthopyroxene compositions show broad systematic variation with orebody proximity, these trends are modified by postcumulus processes that must be considered when establishing chemical baselines. Integration of mineral chemistry with petrographic context is therefore critical for utilising ferromagnesian silicates as prospectivity indicators or exploration vectors.

Presentation Type:
Oral

Lateral geochemical variation in the Bushveld Complex: proxies towards the feeder conduits?

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We present new high-precision data on the concentrations of PGE (Os, Ir, Ru, Rh, Pt, Pd) and Au in the silicate rocks of the interval between the UG2 chromitite and the Merensky Reef in the western limb of the Bushveld Complex. We compare our results to previous data from our group and those of other authors from Union Section, Northam mine, and Rustenburg section. The data indicate a broad trend of elevated PGE contents at Amandelbult and Northam sections, with slightly lower levels at Union section (particularly in norites and anorthosites), and still lower levels in the southern portion of the western limb. This trend broadly correlates with differentiation indexes such as Mg# of whole rocks and orthopyroxene, and An content of plagioclase which also decrease from the NW to the SE of the western lobe. The data suggest that the PGE budget of the silicate rocks in the Bushveld Complex can be used as a proxy towards the magma feeder zones. The data also provide some intriguing insights on petrogenesis: the norites and anorthosites all contain more PGE than could be hosted by the trapped melt. The PGE are apparently controlled by sulfide as suggested by good correlations with Cu, Au, S and Ir. Cu/Pd in these rocks is significantly below mantle, thus there is no evidence of PGE depletion resulting from the formation of the UG2 and the Pseudoreef. We consider two possible models, i.e. sulfides could have been entrained in the magmas from which the norites and anorthosites formed, or sulfide melt percolated from the reefs into their footwall rocks.

Presentation Type:
Oral

Constraining the origin and nature of the Eagle's Nest intrusion, McFaulds Lake Greenstone Belt, Ontario, Canada

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The Eagle's Nest intrusion is a mafic-ultramafic, blade-shaped dike that hosts orthomagmatic Ni-Cu-(PGE) mineralization in the Ring of Fire region of Ontario. It is part of the Koper Lake subsuite of the more voluminous Ring of Fire Intrusive Suite (~2736–2732 Ma) within the Meso- to Neoarchean McFaulds Lake Greenstone Belt. The Eagle's Nest intrusion can be subdivided into the marginal and inner zones. The marginal zone is composed of gabbroic rocks that exhibit the most evolved mineralogical and geochemical characteristics, with intense alteration that preserves primary magmatic textures. Contacts with the host tonalite reflect a prolonged high magma flux, but only rarely preserve evidence of rapid cooling and chilled margins. The marginal zone gradationally transitions into the inner zone, which consists of ultramafic ortho- to mesocumulate rocks. The inner zone is characterized by coherent linear geochemical trends that reflect olivine and chromite accumulation with variable proportions of intercumulus silicate phases and interstitial sulfides.

A new parental magma composition estimate was established using olivine and chromite mineral chemistry, combined with whole rock geochemistry of ultramafic cumulate rocks. The estimate yielded a parental magma composition that contained ~15 wt % MgO and ~11 wt % FeOt, consistent with a komatiitic basalt magma. Whole rock geochemistry and Sm-Nd isotopes show that the Eagle's Nest magma was derived from a depleted mantle source, above the garnet stability field, which then underwent extensive crustal contamination from multiple sources that included both the host tonalite, and older supracrustal rocks. $\Delta^{33}S$ values suggest that crustal contamination by sulfur-bearing supracrustal rocks likely contributed to attaining sulfur saturation of the magma. The distinctive petrological and metallogenic characteristics of the Eagle's Nest intrusion are likely the result of several distinct processes involving both emplacement dynamics and parental magma composition, resulting in unique metal endowments relative to other intrusions in the belt.

Presentation Type:
Oral

Deep-sourced crystal slurries did not control the formation of platinum and chromite reefs in the Bushveld Complex

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One prominent school of thought attributes the formation of platinum and chromite reefs in the Critical Zone of the Bushveld Complex to gravity- and size-induced sorting of minerals within crystal-rich slurries derived from deep magma reservoirs. These slurries, dominated by orthopyroxene phenocrysts, are interpreted to have acted as a transporting medium for chromite grains and platinum-group minerals. If derived from deep reservoirs, orthopyroxene chemistry should therefore record high-pressure crystallization. Recent seismic and gravity imaging has identified a deep staging chamber at depths of ~40–45 km, corresponding to pressures of ~1.0 GPa, thereby constraining the pressure conditions under which any deep-sourced crystal slurries must have formed. Experimental crystallization of Bushveld-type magmas at ~1.0 GPa produces orthopyroxene enriched in Al_2O_3 (~3.5–7.0 wt %) and Cr_2O_3 (~1.7–2.2 wt %), providing a quantitative benchmark for high-pressure crystallization. In contrast, cumulus orthopyroxene in the Critical Zone is systematically depleted in Al_2O_3 (<1.5 wt %) and Cr_2O_3 (<0.5 wt %), irrespective of stratigraphic position or the presence of chromite. Post-emplacement re-equilibration through interaction with coexisting melt is unlikely, as diffusion kinetics and thermal constraints indicate that melt–crystal exchange cannot reset bulk orthopyroxene compositions and would be limited to thin crystal rims. Extensive dissolution–reprecipitation is likewise unsupported, given the preservation of primary zoning patterns and the absence of diagnostic reaction textures. We therefore conclude that orthopyroxene—and, by inference, all other co-crystallizing minerals, including chromite and platinum-group minerals—formed at low pressure within the Bushveld magma chamber itself. These results impose a fundamental mineral-chemical constraint on petrogenetic interpretations and effectively rule out models invoking deep-sourced, crystal-rich slurries. The formation of chromitite and platinum reefs must instead be explained by internal fractionation processes of crystal-free melts within a shallow, melt-dominated Bushveld magma chamber.

Presentation Type:
Oral

Controls on newly discovered Cu-Ni-Co sulfide mineralisation within the Stendalen mafic intrusion, South Greenland

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The Stendalen layered mafic intrusion, Greenland, is a 17.5 km^2, ca. 1300 m thick, saucer-shaped meta-gabbroic intrusion hosting magmatic Cu-Ni-Co sulfide mineralisation. The intrusion lies within S-bearing forearc sediments of the accreted Paleoproterozoic Ketilidian orogenic belt, located on the southern margin of the North Atlantic craton. Zircon U-Pb geochronology of the intrusion has yielded a precise primary crystallisation age of 1804 ± 1.5 Ma; placing Stendalen within the latter stages of the calc-alkaline Julianehåb igneous complex magmatism and indicating that emplacement occurred immediately prior to the peak Ketilidian deformation recorded in the forearc. Consistent with many magmatic sulfide deposits located within orogenic belts, Stendalen is characterised by high Cu and Ni but relatively low PGE values.

The gabbroic rocks of the intrusion comprise a hornblende-clinopyroxene-plagioclase assemblage displaying extensive recrystallisation and amphibolitization interpreted to be a result of the regional HT-LP regional metamorphism. The sulfide assemblage comprises pyrrhotite-chalcopyrite-pentlandite with no hydrothermal overprint. Sulfide mineralisation is disseminated in the upper intrusion but is more prevalent towards the base of the intrusion in close association with vari-textured gabbro. The sulfides display a continuum of primary to deformed textures (blebby, net-textured, sulfide matrix and durchbewegung breccias). Partial loop textures and exsolution flames of pentlandite occur within pyrrhotite alongside granular pentlandite and chalcopyrite. Texturally, on a mm-cm scale there is varying separation of Ni and Cu with the more deformed textures showing clear spatial separation of chalcopyrite from pentlandite-pyrrhotite, and sheared pentlandite fabrics.

Key outstanding mineral system questions that are being investigated are the source of S and trigger to sulfide saturation, through S isotope and S/Se work, and the effect of metamorphism on the distribution of metals in order to develop a petrogenetic model for mineralisation and post-emplacement deformation for Stendalen and related magmatism in the wider region.

Presentation Type:
Student Oral

Application of apatite geochronology in mafic layered intrusions: Apatite reveals multistage emplacement of the Sept-Iles Intrusive Suite (Grenville Province, Canada) during two distinct magmatic episodes related to plume-rifting

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Magma replenishments are common in mafic layered intrusions. The Ediacaran Sept-Iles Intrusive Suite (Grenville Province, Canada) is the third largest mafic layered intrusion in the world and hosts Fe-Ti-P mineralisation. The main Layered Series was previously interpreted as successive mafic injections, defining 3 megacyclic units (MCU). However, our new geochronological data on apatite reveals an unexpected 37 to 57 Ma time-gap during its emplacement.

In situ U-Pb and Lu-Hf geochronology was used to constrain the age of cumulus apatite in fifteen samples. Apatite from the top of MCU I returned U-Pb calculated ages between 604 ± 12 Ma and 623 ± 12 Ma. Apatite from the top of MCU II is considerably younger and yields ages of 556 ± 10 Ma (U-Pb) and 567 ± 14 Ma (Lu-Hf). The U-Pb age obtained on zircon from a granophyric pocket towards the top of MCU II (564 ± 2 Ma) is consistent with MCU II apatite ages. The time-gap between MCU I and MCU II reveals that the Layered Series was emplaced during at least two distinct magmatic episodes. The age of MCU I is coeval with the mantle plume phase of the Central Iapetus Magmatic Province (615 – 570 Ma) whereas MCU II is coeval with the opening of the Iapetus Ocean on the margin of Laurentia (570 – 510 Ma). The trace element content of cumulus apatite from MCU I (high $(Gd/Yb)_N$ ratio) is coherent with partial melting of a plume at depth. The lower $(Gd/Yb)_N$ ratio of cumulus apatite from MCU II is consistent with decompression melting of shallow asthenospheric mantle during rifting, following a mantle-plume phase. Combined with the evolution of mineral compositions along the stratigraphic sequence, our study suggests that MCU II was emplaced as a sill into the older MCU I.

Presentation Type:
Oral

Re-Os isotope and platinum-group element abundance systematics of the Guli ultramafic massif, Polar Siberia

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The Guli massif in the northern part of the Siberian Craton hosts one of the world's largest Os−Ir placer deposits. It exhibits features typical of both zoned-type clinopyroxenite-dunite and ophiolite dunite-harzburgite massifs. In this study, we present new Re-Os isotope and platinum-group element (PGE) abundance data for dunites and chromite and olivine separates from the Guli massif. We use these and previously published (Malitch et al., 2024) data to constrain the timing, possible mechanisms of the massif formation, and the source of the PGE inventory. The studied dunites are characterized by W-shaped CI chondrite normalized PGE patterns, with extreme Os−Ir, and Pt-Pd depletions (0.03-0.3 ppb and 0.02-0.2 ppb, respectively) and a maximum at Ru (0.93-1.4 ppb). This extreme PGE depletion of the host dunites is in sharp contrast with the highly PGE-enriched nature of the associated podiform chromitites and Os−Ir alloys of the massif, pointing to their complementary nature and likely a common origin. The Re−Os internal errochron age of 252 ± 40 Ma (MSWD=27) confirms the formation of the massif and its mineralization at the Permian-Triassic boundary, coeval with the formation of the spatially closely associated Siberian Traps large igneous province. The initial γ^{187}Os value of -1.2 ± 0.5 derived from the errochron is within the range of chondritic meteorites at the time of the massif formation, indicating that the massif was derived from the source, which evolved with a time-integrated near-chondritic Re/Os ratio. This initial γ^{187}Os value is identical, within their respective analytical uncertainties, to the initial γ^{187}Os values obtained previously for podiform chromitites and Os−Ir rich alloys from the placer deposits, both genetically related to the Guli massif, and indicate derivation of the bulk of the PGE inventory of the massif from convecting, asthenospheric upper mantle.

This study was supported by the Russian Science Foundation (project No. 25-17-00116).

Presentation Type:
Oral

Ni–Co-fertile magmatism linked to tectonic switching during the Tethyan orogenic cycle

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Magmatic nickel–cobalt (Ni–Co) sulfide deposits are typically associated with extensional settings, yet the giant Xiarihamu deposit formed in the East Kunlun orogen (northern Tibet). To resolve how an orogenic system generated exceptional Ni–Co fertility, we combine in situ secondary ion mass spectrometry (SIMS) zircon uranium–lead (U–Pb) geochronology with zircon trace-element proxies and oxygen–hafnium isotopes ($\delta^{18}O$ and εHf(t)) from four drill cores across the intrusion.
Gaussian mixture modeling, optimized using the Bayesian information criterion and evaluated with radial plots, resolves four discrete magmatic pulses at ~477, ~451, ~429, and ~409 Ma (million years ago), indicating incremental construction of the ore-bearing mafic–ultramafic complex over ~70 million years. Zircon oxybarometry reveals that the magma became progressively more oxidized, with oxygen fugacity (fO_2) shifting from reduced early pulses (median ΔFMQ ≈ -3.7; log units relative to the fayalite–magnetite–quartz (FMQ) buffer) to moderately oxidized late pulses (median ΔFMQ ≈ -1.9 to -1.8). Water-content indicators in zircon, including increasing (Ce/Nd)/Y and muted europium anomalies (Eu/Eu*), suggest progressively more hydrous magmas. These coupled redox–volatile shifts suppress early plagioclase saturation and prolong mafic silicate fractionation, enabling Ni–Co to accumulate in the silicate melt before sulfide saturation. The youngest pulse, emplaced under moderately oxidized yet sulfide-stable conditions, likely triggered sulfide immiscibility after crustal sulfur assimilation, focusing Ni–Co-rich sulfides into multiple trap sites within a heterogeneous, multi-level intrusion. Inherited Neoproterozoic zircons and Hf model ages clustered at ~800–900 Ma indicate a long-lived, plume-enriched lithospheric mantle domain that was reactivated during Proto-Tethyan tectonic transitions from arc magmatism to slab break-off and post-collisional extension. Xiarihamu demonstrates that multi-pulse, progressively oxidized–hydrous magmatism can generate world-class Ni–Co sulfide systems in convergent orogens, providing exploration criteria for analogous tectonic-switch settings.

Presentation Type:
Oral

New constraints on the timing and controls of Ni-Cu-PGE Mineralization in the Midcontinent Rift

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We present new insights from the Geological Survey of Canada's ongoing Targeted Geoscience Initiative (TGI) research on North America's Midcontinent Rift, focusing on refining the temporal and geodynamic framework of rift magmatism and associated Ni-Cu-PGE mineralization. High-precision U-Pb geochronology on a suite of mafic-ultramafic intrusions constrains the timing and tempo of magmatism, revealing that ore formation is linked to discrete magmatic episodes coinciding with the main volcanic phases of the rift.

Our results highlight a pronounced structural reorganization of the rift axis from NW–SE to SW–NE, coinciding with emplacement of the Duluth Complex and the concentration of magmatism and mineralization into a narrow structural corridor along the western shore of Lake Superior. A temporal overlap with magmatism of the Southwestern Laurentia large igneous province suggests a continent-scale geodynamic linkage during the Mesoproterozoic, reinforcing the interpretation that late-stage Midcontinent Rift magmatism was part of a broader plume-influenced event.

At the deposit scale, new ages reveal greater complexity and longevity in the evolution of many of the mineralized intrusions. Multi-phase systems such as Tamarack and Crystal Lake record prolonged and dynamic magmatic histories, consistent with sustained magma flow. At Crystal Lake, mineralization is linked to early, volatile- and sulphur-rich magma pulses delivered laterally by the Mount Mollie dyke. A shift from vertically focused magma flow to lateral magma transport emerges as a key control on sulphide accumulation, offering new insights into upper-crustal processes governing ore formation.

We also present new regional and deposit-scale datasets (e.g., Lu–Hf and S isotopes) that provide additional temporal and spatial constraints on Ni-Cu-PGE ore formation across the Midcontinent Rift.

Presentation Type:
Oral

Ni and Cu isotope ratios as novel tracers of sulfide-silicate liquid immiscibility

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Sulfide-silicate liquid immiscibility plays a significant role in the processes of planetary-scale differentiation, the formation of Earth's crust, and the genesis of magmatic sulfide ore deposits. The stable isotope geochemistry of nickel and copper can potentially take advantage of fractionation signals produced in magmatic systems where immiscible sulfide and silicate liquids have equilibrated. Variations in Ni and Cu isotope ratios beyond those found in sulfide-undersaturated basaltic rocks can provide a hallmark of fractionation processes that control chalcophile and siderophile element abundances. We report high-precision Ni and Cu isotope ratio data for a stratigraphically controlled sequence of Siberian Trap basalts in a volcanic edifice centered over the world's largest concentration of magmatic sulfide ore deposits at Noril'sk-Talnakh, Russia. Nickel and Cu isotope ratios in the basaltic rocks correlate negatively with Ni, Cu, and precious metal abundance levels, indicating extensive Ni and Cu isotope fractionation due to sulfide saturation of the silicate magma. A Rayleigh fractionation model fits the observed results and enables precise estimates of the fractionation factor (α) between sulfide liquid and silicate melt to be ~0.99965 (i.e., 103*lnα = −0.35) for Ni isotopes and ~0.99983 (i.e., 103*lnα = −0.17). Our study illustrates the application of Ni and Cu isotope ratio data in understanding sulfide-silicate liquid immiscibility and the broader implications with respect to the formation of the largest known magmatic sulfide ore deposits in association with the Siberian Trap.

Presentation Type:
Oral

Mineral prospectivity of the Ordovician mafic-ultramafic intrusions of Northeast Scotland

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The Caledonian mafic-ultramafic intrusions of Northeast Scotland are recognised as prospective for critical raw materials, including nickel (Ni) and cobalt (Co) [1]. This suite encompasses ~10 intrusions emplaced into the Dalradian metasedimentary sequence of the Grampian Highlands during arc-continent collision and peak regional metamorphism (c.470 Ma) associated with the Grampian Orogeny (c.488-461 Ma) [2]. Active exploration is ongoing at the Arthrath (Aberdeen Minerals Ltd.) and Huntly-Knock (Peak Nickel Ltd.) intrusions, known to contain magmatic Ni-Copper (Cu)-Co sulfide mineralisation [3]. Prospectivity of the other intrusions is unclear.

This research addresses regional and intrusion-scale uncertainties around the timing of emplacement and controls on sulfide mineralisation. Existing age data is dispersed 30+ Myrs around ~470 Ma [4], thus it is unclear if intrusions were emplaced contemporaneously [5] or as temporally distinct bodies [6]. These age data do not demonstrate temporal differences between mineralised and unmineralised intrusions or between mineralised and unmineralised units within intrusions. Several intrusions of potential economic interest have no age data (e.g., Arthrath). Assimilation of crustal material is an important trigger for sulphur saturation in magmatic sulfide deposits [7]. The sulphur/selenium geochemical data from mineralised units in Arthrath and Knock [8] and the presence of xenoliths [9] reflect a crustal contaminated magma. It is unclear if there is any systematic variation in the extent of crustal contamination between and within intrusions. The magmatic stratigraphy, distribution of and controls on mineralisation within intrusions is poorly understood.

This study involves regional sampling, petrology and whole-rock geochemistry. Detailed core logging of Arthrath will constrain the magmatic stratigraphy and local mineralisation controls. High-precision U-Pb zircon geochronology and Lu-Hf isotope analyses will address uncertainties around intra- and inter-pluton temporal variability and temporal and/or crustal contamination controls on mineralisation. This work will directly contribute to the developing exploration model at Arthrath and the Northeast Scotland region.

Presentation Type:
Student Oral

Origin of high-Pd pentlandite and multiple platinum-group minerals in the disseminated sulfide ores of the J-M Reef, Stillwater Complex

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The J-M reef of the Stillwater Complex has the highest Pt+Pd grade of all known reef-type PGE deposits in the world, and most of Pd and Pt in pentlandite, Pt-Pd sulfide and Pt-Fe alloys. X-ray fluorescence mapping, scanning electron microscopy, electron probe micro-analyzer and transmission electron microscopy were used to determine the distribution, morphology and compositions these minerals. There are two types of pentlandite in J-M Reef samples. Firstly, most of pentlandite has high Pd contents, containing up to 2.16 wt % Pd, and fall in the field of high-form pentlandite. Based on the geochemical compositions and previous experimental Pd-Fe-Ni-S phase system, the high-Pd pentlandite could be transformed by high-form pentlandite formed from high-temperature (800-900 °C) Ni-rich fractionated sulfide liquid. Secondly, some high-Pd pentlandite grains exhibit a spatial association with braggite and have a very high Pd content 9.64–10.59 wt %, the ideal formula is $PdNi_8S_8$, which is a new Pd end-member mineral of the pentlandite group, Wangnite (IMA 2024-008a) and has been approved by the CNMNC. In wangyanite, Pd occupies the site with octahedral coordination. On the other hand, the isoferroplatinum grain surrounded by braggite grain is as a round grain, with Pt of 85.93-89.47 wt %, Ni of 0.11-1.71 wt % and minor Pd, which could crystallize from silicate melt before sulfide saturation at high magmatic temperature (>1000 °C). Braggite grains are closely associated with the base metal sulfides (BMS), and the mapping show that Pt content in grain decreases from core to rim, whereas Pd is increasing from core to rim, indicating that the braggite crystallizes from sulfide liquid and the Pd content of braggite would be increasing with temperature decreasing (1000-800 °C). The variety of processes and mechanisms may explain the variability of high-Pd pentlandite and PGMs observed along the J-M Reef.

Presentation Type:
Oral

Magmatic plumbing system of the Xiarihamu Ni–Cu sulfide deposit, China: Constraints from zonation, chemistry, and in-situ oxygen isotopes of poikilitic and cumulus orthopyroxene

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The Xiarihamu Ni–Cu sulfide deposit contains 157 Mt of sulfide ore averaging 0.65 wt % Ni and 0.14 wt % Cu, ranking as the world's 20th-largest magmatic Ni–Cu sulfide deposit. Economic mineralization is confined to the No. 1 intrusion, composed of an older mafic unit (~430 Ma) and a younger ultramafic unit (~410 Ma) hosting the sulfide ore bodies. The ultramafic unit is subdivided into a western olivine-bearing phase (harzburgite and olivine websterite) and an eastern olivine-free phase (orthopyroxenite and websterite). Despite extensive study, the petrological relationship between these two phases and the magmatic plumbing system remains poorly constrained. Our results show that the two phases are in gradational contact, marked by a progressive decrease in olivine and a corresponding increase in orthopyroxene. Orthopyroxene in the olivine-bearing phase is poikilitic and contains resorbed olivine chadacrysts, whereas orthopyroxene in the olivine-free phase is cumulus and contains little or no olivine. Poikilitic orthopyroxene displays inner sector zoning and outer oscillatory zoning, whereas cumulus orthopyroxene exhibits variable reverse and normal zoning. The Mg# of both orthopyroxene types decreases with compatible elements such as Cr and Ni, consistent with fractional crystallization. The inner sector zoning is characterized by lower average $\delta^{18}O$ values (6.29 ‰) than the outer oscillatory zoning (6.77 ‰), which are comparable to those of cumulus orthopyroxene (6.84 ‰). These features indicate that a later Si-rich magma interacted with pre-existing olivine cumulates, triggering rapid growth of sector-zoned orthopyroxene oikocrysts enclosing resorbed olivine. Subsequent interaction between this magma and the surrounding country rocks led to enhanced crustal contamination and elevated $\delta^{18}O$ values, producing the outer oscillatory zoning of poikilitic orthopyroxene. Continued fractional crystallization subsequently generated cumulus orthopyroxene in the olivine-free phase of the eastern section. These results suggest that future exploration should focus on the deeper parts of the pre-existing olivine-bearing phase in the western section.

Presentation Type:
Oral

The dual role of S assimilation in Norilsk sulfide magma conduits

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The key role of crustal sulfur assimilation in the formation of Norilsk sulfides is largely supported by their sulfur isotope compositions enriched in the heavier 34S isotope. However, large-scale assimilation inevitably affects the bulk composition of sulfides also. To reveal the relationship between the extent of assimilation and metal tenor variations, we compiled a database, which includes our new and literature data on the bulk ore and the sulfur isotope compositions (more than 1400 analyses in total) from orebodies of 4 major deposits (Norilsk 1, Norilsk 2, Talnakh, and Kharaelakh). Four principal ore types (disseminated, high-Rh massive, Cu-deficient massive, and Cu-rich massive ores) are identified based on their textures and geochemical parameters such as Cu/Ni and Pd/Rh. The new type of high-Rh ores with Pd/Rh<10 is recognized as the most primitive cumulates of the least contaminated magmas at each deposit. The general trend of inverse correlation between PGE tenor and $\delta^{34}S$ is consistent with dilution of the initially PGE-richer immiscible sulfide melt due to excess sulfur input during progressive contamination. At the same time, fractional crystallization acts independently towards Pt+Pd enrichment of Cu-rich residual liquid, overwhelming the general PGE depletion, as seen in Cu-rich ores of the Oktyabrsk Main Orebody. Complementary lateral variations in the isotope-geochemical parameters within the Talnakh and Kharaelakh intrusions advocate for on-stage contamination in the resident conduits. The contrasting average $\delta^{34}S$ values and associated metal tenors for the 4 deposits are explained by differences in the morphology of their feeder channels and the lithology along the magma pathways.

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Presentation Type:
Oral

Iron-rich ultramafic pegmatites in the Rustenburg Layered Suite: Field observations and a review of competing petrogenetic models

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Iron-rich ultramafic pegmatites (IRUP) are discordant bodies that crosscut the Rustenburg Layered Suite (RLS) of the Bushveld Complex and locally disrupt mining by redistributing and altering platinum-group minerals. IRUP display stratigraphically controlled mineral assemblages, ranging from olivine-clinopyroxene dominated types in the Upper Critical and Lower Main Zones to Fe-Ti oxide dominated types in the Upper Main and Upper Zones. They tend to preferentially replace plagioclase rich host cumulates.

A magmatic replacement origin, similar to dissolution-reprecipitation, has been proposed for the petrogenesis of IRUP, supported by isotopic evidence and high-temperature mineral assemblages. An alternative model proposed in earlier studies is hydrothermal replacement, based on the absence of field evidence typical of high-temperature magmatic intrusions, such as chilled margins and baked contacts. The crystallizing cumulate pile of the RLS has been proposed as a source of the replacement agent through residual melt accumulation, liquid immiscibility, or partial melting of host cumulates. In contrast, generation of the melt external to the RLS, followed by upward emplacement, has also been proposed.

Field observations provide direct evidence for a replacive origin. IRUP preferentially replace plagioclase-rich host rocks, with both upward and downward migration, without disrupting the primary stratigraphy. Modal mineralogy and grain size vary both between localities and within individual bodies, with clinopyroxene as the dominant phase accompanied by magnetite, olivine, and plagioclase. Plagioclase abundance increases toward host-rock contacts. Microtextures from the Tweefontein IRUP include clinopyroxene with orthopyroxene cores and hornblende rims, indicating H_2O involvement.

Overall, field and textural evidence is most consistent with replacement by magmatic melts (± fluids) derived from the cumulate pile. Given the economic significance of IRUP and the continued uncertainty surrounding their origin, an integrated model incorporating new field, petrographic, and geochemical data across the RLS is required.

Presentation Type:
Student Oral

Platinum-group mineral assemblages from magnetite clinopyroxenites and detrital Pd-bearing gold nuggets of the Guli massif (Polar Siberia)

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The Guli massif is one of several ultramafic-alkaline complexes located within the Maimecha-Kotui Province in the northern part of the Siberian Craton. It is remarkable for its considerable size (approximately 2000 square km) and the spatially associated complex Au-Ir-Os placer deposits (Malitch, Lopatin, 1997). In this study, we present compositional data for platinum-group mineral (PGM) assemblages, which were firstly identified in magnetite clinopyroxenites forming a stockwork-like zone in dunites exposed in the northern part of the Guli massif, and rare Pd-bearing gold nuggets from the Gule River placer deposit. We use these and previously published data (Lopatin et al., 2002; Malitch et al., 2024) to constrain primary sources of noble metal mineralization in placers. A detailed in-situ examination of polished sections of magnetite clinopyroxenites revealed a suite of single and polyphase euhedral inclusions consisted of Pt- and Pd-bearing PGM grains (sperrylite ($PtAs_2$), stibiopalladinite ($Pd_{5+x}Sb_{2-x}$), geversite ($PtSb_2$), moncheite ($PtTe_2$), tetraferroplatinum (PtFe) and Pt-Cu alloy) ranging in size from 1 to 5 µm. The identified PGM are hosted by rock-forming minerals (Ti-bearing magnetite and diopside), indicating their synchronous crystallization under low sulfur fugacity and high-to-moderate temperature conditions. Detrital Pd-bearing gold nuggets are characterized by Au, Pd and Cu contents (wt %) varying within 88.74-94.58, 4.74-6.97 and 0.60-4.07, respectively. They contain numerous solitary inclusions of sperrylite and isomertieite ($Pd_{11}Sb_2As_2$) in the size range of 3-20 µm, and rare polyphase inclusions composed of moncheite, pentlandite, chalcopyrite and bornite. The results of this study, combined with predominance of Pt and Pd contents over other platinum-group elements in clinopyroxenites (Malitch et al., 2024), and high Au contents identified around clinopyroxene-rich lithologies during surficial multielement geochemistry surveys (Lopatin et al., 2002), indicate that detrital Pd-gold grains were likely derived from magnetite clinopyroxenites of the Guli massif.

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Presentation Type:
Oral

In situ apatite compositional constraints on volatile evolution in orogenic Ni–Cu systems as exemplified by the Xiarihamu deposit

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Volatiles may play an important role in the formation of magmatic Ni–Cu deposits, particularly those emplaced in orogenic belts where magmas are commonly hydrous. Apatite is widely used as an indicator mineral for tracing the composition, behavior, and evolution of magmatic volatiles. In this study, we present textural characteristics, trace-element compositions, and in situ hydrogen isotopic data for apatite from the Xiarihamu Ni–Cu deposit hosted by websterite and lherzolite in the East Kunlun Orogenic Belt. The aim is to constrain apatite crystallization sequences and to elucidate magma evolution and volatile behavior. Texturally, apatite is classified into seven groups based on host minerals and inclusion relationships: apatite enclosed in clinopyroxene, amphibole, plagioclase, biotite–phlogopite, sulfide, quartz, and interstitial domains. Geochemically, apatite hosted by silicate minerals is dominantly OH-rich, whereas some interstitial apatite is Cl-rich. All apatite grains are enriched in light rare earth element (REE) and depleted in heavy REE, with Cl-rich apatite showing more pronounced heavy REE depletion. In contrast, apatite enclosed in pyrrhotite within massive sulfide breccia is F-rich and displays relatively flat REE patterns accompanied by a strong negative Eu anomaly. These features suggest that OH-rich, Cl-rich, and F-rich apatite record crystallization from silicate melt, vapor-saturated interstitial melt, and degassed silicate melt, respectively. Apatite from the Xiarihamu deposit therefore preserves a detailed record of magmatic evolution processes, including fractional crystallization, magma degassing, and late-stage fluid exsolution. Collectively, the apatite data indicate that orogenic Ni–Cu systems are characterized by hydrous magmas and the development of vapor saturation during magmatic differentiation. In contrast, our apatite-based volatile record indicates that, although hydrous and vapor-saturated conditions developed during magmatic differentiation at Xiarihamu, the “sulphide–vapour compound drop flotation” mechanism was unlikely to have played a dominant role in sulphide transport in this deposit.

Presentation Type:
Student Oral

Magmatic Ni-Cu deposits in the Central Asian Orogenic Belt driven by the Permian Tarim Plume

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Late Paleozoic magmatic Ni-Cu-Co sulfide deposits in the Eastern Tianshan-Beishan area play an important role in Chinese Ni-Cu resources and are characterized by occurring in the Central Asian Orogenic Belt (CAOB) and by hosting small intrusions or dikes. There have long been debates over their tectonic settings, such as orogenic extension, accretionary arc, and mantle plume. Zircon SIMS U-Pb dating of a series of Ni-Cu-bearing and Ti-Fe-bearing mafic-ultramafic intrusions in the Eastern Tianshan and Beishan Rift yields a relatively restricted range of 278.6 Ma to 285.0 Ma. The histogram of compiled age data for basalts in the Tarim Basin and mafic-ultramafic intrusions in the Eastern Tianshan and Beishan Rift shows a peak at 280 Ma, which probably represents the time of mantle plume activity. The complexes have positive bulk eNd(t) and zircon eHf(t) values, suggesting that their parental magmas were derived from depleted mantle sources. We observed that the number of mafic-ultramafic intrusions decreases with increasing distance from the Tarim craton (Tarim plume), and these intrusions show a 7–8-m.y. time lag in their emplacement ages (295–255 Ma, with peaks at 293 Ma, 282 Ma, and 271 Ma) with respect to the timing of Tarim LIP magmatism (300–270 Ma) within the Tarim craton. These unusual geochronological and tectonic links suggest that the plume materials were escaping to the northeast along an extensional belt in the southern CAOB, which is perpendicular to the inferred circular boundary of the plume, prolonging the lifetime of the Tarim plume. Furthermore, some potential targets have been selected, and significant breakthroughs in exploration have been made in Xinjiang.

Presentation Type:
Oral

Formation of high-temperature pyrite in intrusions of the Ni–Cu–Co-prospective Fraser Zone, Western Australia

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Pyrite in Ni–Cu–Co magmatic sulphide mineralisation, which typically consists of pyrrhotite, pentlandite, and chalcopyrite, is usually interpreted as a secondary phase formed sub-solidus. Pyrite formed above the solidus is difficult to reconcile with Fe–Ni–S phase relations because the S content of S-rich liquids is rarely sufficient to form pyrite at high temperatures. This is because S-rich liquids typically react with country rocks to strip Fe from Fe-rich silicates. However, experiments have shown that primary pyrite can form from a sulphide liquid. In addition, the relevant phase relations are not well known at high pressure.

The Fraser Zone, Western Australia, is an orogenic belt that records metamorphism during the Proterozoic Albany–Fraser Orogen at pressures of 7–9 kbar and temperatures of ~850 °C. Pyrite is present with pyrrhotite, pentlandite, and chalcopyrite in samples from several localities. These rocks host two types of pyrite that are petrographically and geochemically distinct. One type is interpreted as secondary and formed by replacement of pyrrhotite. The second type shows characteristics more consistent with formation at high temperature.

To explain the formation of pyrite at high temperature, we propose the expansion of the pyrite stability field under granulite facies metamorphic conditions coincided with a pressure-induced decrease in the temperature of the silicate solidus. These shifts created a window in which a sulphide liquid could assimilate enough S to produce pyrite. Phase relations indicate that pyrite is unlikely to coexist with Ni-bearing sulphides, so the presence of supra-solidus pyrite has implications for prospectivity.

Presentation Type:
Oral

Formation of mantle dunitic channels in oceanic spreading centers: Implications for complexity of melt extraction and Cr enrichment

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How do the formation and operation of dunitic channels regulate the melt extraction and Cr enrichment under a spreading center remains unclear. In this study, we focused on the Dazhuka ophiolite (South Tibet), a product formed in the Neo-Tethyan spreading center, to reveal the formation of dunitic channels and its effects on melt extraction and Cr enrichment. Through detailed petrographic observations and geochemical analyses, we found that these dunites can be divided as three types: Type 1, 2 and 3A/3B dunites. 1) From Type 1 to Type 2 dunites, the content of orthopyroxene (Opx) is gradually decreasing until Opx is all consumed, while the diameter of olivine (Ol) is gradually growing up to 2-3 cm. Geochemical evidence shows gradually increasing of Mg#-whole rock (0.91-0.93), Cr#-spinel (Spl; 0.46-0.83) and LREE/HREE-clinopyroxene (Cpx, 0.08-1.42), but decreasing of Re/IrN (normalization to primitive upper mantle)-whole rock (30.7-0.06). These phenomena indicate reaction between wall-rock harzburgites and silica-unsaturated melts depleted in PPGE elements. 2) From Type 2 to Type 3A/3B dunites, Mg#-whole rock (0.93-0.87), Cr#-Spl (0.83-0.24), and LREE/HREE-Cpx (1.42-0.02) decrease back to fertile endmembers, while Re/IrN-whole rock increases (0.06-0.43), suggesting interaction between Type 2 dunites and MORB-like melts rich in PPGE elements. We therefore suggest that in the first stage, silica-unsaturated melts were formed by stronger asthenospheric upwelling and reacted with wall-rock harzburgites to gradually form Type 1 and Type 2 dunites. In the second stage, the upwelling of asthenosphere with the dunitic channels became weaker, ambient silica-saturated melts were focused into the dunitic channels and reacted with Type 2 dunites to form Type 3A/3B dunites. This study shows that asthenospheric upwelling and melt extraction may be pulsed under an oceanic spreading center, and the Cr enrichment can occur in a short length scale during mantle melt extraction.

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Presentation Type:
Oral

Wetting of olivine by sulfide liquid: an example from the Central Asian Orogenic belt in NW China

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Elongated sulfide-olivine patches (SOPs) occur within the Dahuangshan mafic-ultramafic complex of the Huangshan-Jingerquan Ni-Cu sulfide metallogenic belt along the southern margin of the Central Asian Orogenic Belt, NW China.

Most of the thinner SOPs display sharp boundaries against the host lherzolite matrix, whereas some of the thicker SOPs exhibit irregular morphologies and may occur in stacked arrangements. Compared with the lherzolite matrix, SOPs contain higher contents of olivine and finer olivine grain sizes. They consist primarily of partly serpentinized olivine with interstitial sulfides that form a fully interconnected network. The sulfide assemblage is dominated by pyrrhotite, accompanied by minor pentlandite and trace chalcopyrite.

SOPs occur as isolated, flattened ellipsoids whose consistently oriented long axes preserve evidence of primary magmatic lamination and lineation. These features contrast sharply with the random-chain structure of typical patchy disseminated ores and could be interpreted as entrained and redeposited sulfide-olivine mushes originally formed at the base of a magma conduit. Low olivine-olivine-sulfide dihedral angles, low (Ni+Cu+Co) contents within the sulfides, and elevated oxygen fugacity of patches collectively indicate that the olivine was wetted by sulfide liquid. This implies that olivine-sulfide aggregates may remain mechanically stable during magma flow, and further that “patchy net-textures” are not necessarily formed by in-situ sulfide percolation. Isolated SOPs may therefore be a characteristic of relatively oxidised, low-tenor ore-forming systems.

Presentation Type:
Oral

Two types of chromitites in Madagascar

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The Precambrian basement of Madagascar hosts numerous yet poorly studied chromitite occurrences. Chromitites from the Andriamena greenstone belt are typical high-Cr type with chromite Cr# values > 60. Trace-element patterns of chromites are characterized by Ni and Sc depletions and Zn, Co, and Mn enrichments. The whole-rock PGE patterns exhibit Rh, Pt, and Pd depletion relative to Os, Ir, and Ru, similar to those observed in podiform chromitites. Zircon U-Pb dating suggests that chromitite formed between ~2.76 and ~2.67 Ga. The mineral and whole-rock geochemistry of chromitites from the Andriamena greenstone belt suggests that the chromitite-forming parental magma was boninitic.

The Ranomena deposit, a representative example in the North Toamasina chromite district, is hosted within lenticular mafic-ultramafic bodies of the Betsimisaraka / Anaboriana-Manampotsy domain. The chromitites exhibit disseminated to massive textures with cumulus chromite and orthopyroxene as the primary intercumulus silicate. Chromite compositions are high-Cr (Cr# mostly >60) with elevated TiO_2 (0.18–0.78 wt.%) and trace-element signatures (enrichments in Ti, Zn, Co, Mn, V, Sc; depletions in Ga, Ni) resembling those of stratiform chromitites. Whole-rock PGE patterns show relative enrichment in Os, Ir, Ru, and Rh over Pt and Pd, akin to the Lower Group chromitites of the Bushveld Complex. Zircons from chromitite samples yield concordia U−Pb ages of 530.4 ± 2.2 Ma and 525.3 ± 2.3 Ma, respectively. Their δ18O values (4.7–6.1 ‰) and εHf(t) values (−5.4 to +6.8) indicate variable degrees of crustal contamination. We concluded that the Ranomena chromitites are coeval with postcollisional granitic magmatism in the central East African Orogen. We propose that they crystallized from mafic magmas generated during lithospheric delamination and asthenospheric upwelling in a post-collisional extensional setting.

Presentation Type:
Oral

Origin of mantle heterogeneous magma conduit model in podiform chromitite

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Podiform chromitites in the Guleman ophiolite (Turkey) exhibit nodular textures critical for deciphering chromite enrichment. Integrated microstructural analyses (EBSD, HRXCT, EMP) reveal chromite nodules lack crystallographic preferred orientation and intragranular deformation, indicating primary static crystallization. Geochemical data demonstrate uniform Ti-Al concentrations in parental melts (TiO_2: 0.10–0.25 wt.%; Al_2O_3:10.57–11.26 wt.%), derived from fluid-metasomatized mantle with subducted crustal contributions. Phase equilibrium modeling confirms high-Cr chromitites (Cr# 79–82) formed via reaction of low-Si boninitic melts with harzburgite at melt-rock ratios of 1:10. We propose a three-stage conduit model: (1) boninitic melt-channel initiation, (2) continuous melt-rock reaction along channel bases supplying olivine and chromite, and (3) convective sorting generating nodular and massive chromite. This resolves the paradox of localized chromite enrichment and highlights melt-channel dynamics in mantle-hosted mineralization.

Presentation Type:
Oral

Noble metal transport by anatectic metalloid nano-melts

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Noble metals (NM) occur in crustal and mantle rocks at parts-per-billion levels, yet the processes driving their extraction, transport, and economical accumulations are debatable. Proposed first-order mechanisms include partitioning into immiscible sulfide melts, incorporation into Cr-spinel within basaltic magmas, with the suspension transport of insoluble nanomaterials playing a key role. However, the controls on NM mobility, transport, and precipitation during metamorphism remain comparatively poorly constrained. Here, we present evidence for NM (Pd, Au) mobilization in low-temperature (<~500 °C) nano-to-microscale metalloid-rich (Te-As-Bi-Sb; TABS) melts generated during metamorphic anatexis (940–990 Ma and/or 635–500 Ma) of precursor (or magmatic) Fe-Cu-Ni sulfides in the Noritic Ring Complex (Antarctica). Noble metal phases comprise of Pd-TABS compounds and Au nanoparticles that were deposited along fracture networks and grain boundaries. Metamorphic partial anatexis of precursor Fe-Ni-Cu sulfides generated low-temperature, near-eutectic TABS melts that concentrated liberated NM. The co-occurrence and entrapment of NM-TABS phases with secondary Fe-Ni-Cu sulfides record coupled migration of immiscible anatectic NM-TABS and sulfide melts through the host rock. These findings identify metalloid nano-melts as key drivers of NM transport and enrichment during metamorphism, providing a mechanism for NM and redistribution, decoupling from sulfides, and coalescence into platinum group mineral (PGM) nuggets in prospective ore-forming systems.

Presentation Type:
Poster

Reactivation of metasomatised continental lithospheric mantle during post-orogenic extension: implications from the Hart Dolerite and Speewah Ti–V deposits, North Australian Craton

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The Speewah Ti–V Deposits of the East Kimberley, Western Australia, are hosted by the ca. 1793 Ma Hart Dolerite, a regionally extensive, sill-dominated mafic intrusive suite emplaced into intracontinental basin sediments of the Kimberley Basin. Although commonly grouped within large igneous province (LIP) frameworks, the origin of the Hart Dolerite has remained controversial, with plume-related and lithosphere-derived models both proposed. At Speewah, economically significant Ti–V mineralisation is hosted within a magnetite-rich gabbroic unit that forms the upper part of this sill complex. Mineralisation is laterally extensive and stratigraphically coherent over kilometre scales, with Fe–Ti oxides constituting the dominant ore phase and minor sulphide- and phosphate-bearing intervals locally developed within the same intrusive unit. This architectural association highlights the capacity for substantial metal endowment to develop within modest-volume, lithosphere-derived mafic systems emplaced under restricted structural conditions. Ongoing work is examining mineral-scale geochemical systematics within the Speewah sill to better constrain the processes governing metal distribution in oxide-rich mafic intrusions generated from reactivated continental lithospheric mantle. Together, these results provide a revised geodynamic and petrological framework for the Hart Dolerite and emphasise the importance of lithospheric memory in controlling both magma generation and the architecture of associated mineral systems.

Presentation Type:
Student Poster

Facies characterization of sulfide Cu ore and its hosts along a core from the Caraíba Complex, Vale do Curaçá, Brazil

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The Caraíba Mafic–Ultramafic Complex, located in the Curaçá Valley (Bahia, Brazil), hosts significant Cu sulfide mineralization and forms part of the Itabuna–Salvador–Curaçá Orogen (ISCO). This study focuses on the magmatic controls on sulfide mineralization, integrating lithofacies characterization and ore textures along a 60.1 m drill core interval from the Caraíba Complex. The identified host rocks include coarse- and fine-grained metanorthosite, metagabbro, garnet metapyroxenite, metapyroxenite, garnet gneiss, augen gneiss, and phlogopitite, representing a differentiated mafic–ultramafic magmatic system subsequently affected by deformation and metamorphism. Sulfide mineralization is spatially associated with mafic–ultramafic lithofacies, particularly garnet metapyroxenite and metagabbro, where chalcopyrite, pyrrhotite, and bornite occur as magmatic sulfide pods, interpreted as the result of sulfide segregation and accumulation during magma evolution. These primary sulfides are overprinted by variable degrees of hydrothermal alteration, including phlogopitization, sulfidation, chloritization, carbonation, and magnetite formation. Among these, phlogopitization is the dominant alteration, preferentially affecting ultramafic protoliths.
Hydrothermal sulfides occur as disseminations aligned with foliation, discordant veins and venules, and fracture-controlled concentrations, indicating post-magmatic remobilization of Cu. Despite this overprint, the distribution of ore lithofacies and the dominance of sulfides within specific magmatic units highlight the fundamental role of magmatic processes in controlling Cu mineralization. The integrated textural and lithological evidence supports a hybrid magmatic–hydrothermal system, consistent with IOCG-type affinities, in which primary magmatic sulfide formation was a key precursor to later hydrothermal modification.

Presentation Type:
Student Poster

Research progress on the mantle recycling and its links to Cr-PGE-Ni mineralization

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Our team is currently leading an integrated research project focus on “Mantle recycling and its genetic links to Cr-PGE-Ni mineralization”. Recent progress includes: deciphering mantle heterogeneity through multiple elemental-isotopic systems (Ping XQ et al., 2022 GCA; Zheng JP et al., 2024 Acta Geologica Sinica; Wang QX et al., 2025 CG); elucidating crust-mantle interactions and the formation of ophiolitic chromitites (Xiong et al., 2022 NC; Zhang et al., 2024 NC); unraveling ore-forming processes in layered intrusion-related Cr-PGE-Ni deposits (e.g., Jinchuan, Noril'sk, Bushveld and small-scale deposits in China; Moradi et al., 2025 GCA; Liu et al., 2025 Precambrian Res; She et al., 2025 Lithos); thermodynamic modeling of magma generation mechanisms in intraplate and plate margin settings (Dai et al., 2024 SCES, 2025 G3), and constraining melt activities and PGE mobility in mantle wedges (Wang TT et al., 2025 CG). Ongoing work focuses on Cr mineralization in Archean greenstone belts (e.g., Greenland, Nuggihalli, India and North China) and the Tethyan Suture Zones (e.g., North Qilian and Yarlung Zangbo Suture Zone), high-pressure experiments on Cr-bearing minerals, numerical modeling of mantle magmatism-associated metal migration, and regional-scale comparisons of metallogenic belts. Future research will integrate interdisciplinary techniques—including modern in-situ analysis, first-principles calculations, thermodynamic modeling, big data mining, and deep learning—to advance understanding of Earth multi-sphere interactions and the controls on Cr-PGE-Ni enrichment.

Presentation Type:
Poster

Apatite provides direct age and source constraints in anorthosite-hosted Fe-Ti-P mineralisation of the Grenville Province (Quebec, Canada)

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The Grenville Province hosts numerous Fe-Ti-V-P showings that are spatially associated with Proterozoic massif-type anorthosites that formed during the Grenville orogeny. While V mineralisation (magnetite-dominated ± ilmenite) is associated with the oldest (1300-1100 Ma) andesine-labradorite-bearing (± olivine) anorthosite, Ti mineralisation (hemo-ilmenite-dominated) is associated with younger (1100-900 Ma) andesine- and orthopyroxene-bearing anorthosite. The P mineralisation is dominated by apatite (with magnetite and ilmenite) and occurs as lenses and dykes within andesine-bearing anorthosites, regardless of their age. However, the age and source of the mineralisation itself remain largely unknown. Constraining these would provide a clearer picture on the link between the types of mineralisation and types of massif-type anorthosite and how these change with time.

Our study uses apatite from Fe-Ti-P mineralisation to better constrain its age and its relation to the host anorthosite, and to investigate the nature of its parental magma and its source. Samples were collected from Fe-Ti-P showings from both the older (>1100 Ma; Lac-Saint-Jean anorthositic suite, Vallant anorthosite) and the younger anorthosites (<1100 Ma; Havre-Saint-Pierre anorthosite suite, Vanel, Mattawa and Labrieville anorthosites). Direct dating of the mineralisation is possible through LA-ICP-MS/MS (operated in single quad mode) U-Pb analyses of apatite. Lu-Hf analyses of apatite from the same samples will ensure that we can resolve crystallisation ages from subsequent metamorphic overprinting when present. When possible, U-Pb dates from zircon will also be obtained. Preliminary U-Pb dates of apatite indicate that Fe-Ti-P mineralisation is the same age or slightly younger than their host massif. Apatite U-Pb ages are systematically younger than previously published U-Pb zircon ages of mineralisation. The trace element content of apatite, combined with in situ Srinitial values, will provide important petrogenetic information to investigate the source of Fe-Ti-P mineralisation associated with the different anorthosite massifs.

Presentation Type:
Poster

Paragenesis of copper-enriched sulphides in the Okiep deposits, South Africa

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The Okiep Copper District, located in the Northern Cape, South Africa, is part of the Bushmanland Subprovince of the Namaqualand-Natal Metamorphic Province. The Bushmanland Subprovince comprises polydeformed and metamorphosed rocks that were intruded at ~1060-1030 Ma by the mafic-intermediate Koperberg Suite (KBS). The KBS forms a swarm of irregular and discontinuous sheet- and plug-like bodies that are spatially associated with narrow high-strain zones known as “steep structures”. Copper mineralisation is associated with sulphide-bearing mafic rocks of the KBS. The origin of the copper mineralisation is enigmatic and is generally regarded as magmatic in origin, analogous to magmatic Ni-Cu-PGE systems. It is further hypothesised that the magmatic sulphides were extensively oxidised by regional granulite metamorphism and late-stage, magmatically derived hydrothermal fluids. New field and drillcore samples were studied from the KBS to characterise the styles of copper mineralisation. The rock types included leuconorites and mica-bearing leuconorites. Microtextures revealed deformed plagioclase laths and orthopyroxene grains rimmed by smaller plagioclase, apatite, hypersthene and phlogopite; exhibiting granoblastic polygonal and porphyroblastic textures. Three copper mineralisation styles are recognised, consistent with previous literature. Narrap mineralisation comprises pyrrhotite, pentlandite, magnetite and chalcopyrite, which occur as semi-massive, net-textured vein-like mineralisation and are associated with leuconorites. Narrap mineralisation resembles an MSS assemblage, which is typical of magmatic sulphide ores. Carolusberg mineralisation consists of chalcopyrite, bornite and magnetite and is associated with mica-bearing leuconorite. Carolusberg mineralisation is unusual for magmatic sulphide assemblages. The presence of a transitional mineralisation style (pyrite, pyrrhotite, bornite and magnetite), also associated with mica-bearing leuconorite, suggests Narrap mineralisation was converted to Carolusberg mineralisation by oxidation. Extensive oxidation may have occurred during the regional high-temperature granulite metamorphism that coincided with KBS emplacement. The impact of metamorphism is apparent from the sub-solidus textures of the KBS, observed in the lithological rocks and reactional textures within the Transitional mineralisation.

Presentation Type:
Student Oral

Paragenesis of magmatic sulphide mineralisation in the mafic-ultramafic phase of the Kunene Complex, Angola

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The 1.5–1.37 Ga Kunene AMCG Complex (KC), located in Angola and Namibia, represents one of the largest (53,500 km^2) and best-preserved massif-type anorthosites on Earth. The KC is associated with numerous, relatively small (≤10 km^2) peripheral mafic-ultramafic (MUM) intrusions, some of which host sulphide mineralisation.
Understanding the magmatic processes controlling sulphide paragenesis in these intrusions is critical for assessing their economic potential and for guiding future exploration targeting Ni-Cu-Co sulphide deposits in massif-type anorthosites globally. The KC and its peripheral MUM intrusions remain relatively underexplored due to limited exposure and historical political instabilities in Angola. This study investigated the paragenesis of sulphide mineralisation within five MUM intrusions of the KC, namely Malola, Oncócua, Lufinda, Chibia, and Chiange.
Pyrrhotite is present as the dominant sulphide in the five MUM intrusions studied, followed by chalcopyrite and minor pentlandite, the latter typically occurring as loop textures and exsolution lamellae in pyrrhotite. Pyrite is present only in Lufinda and Chibia. Lufinda comprises contact-style sulphide mineralisation between olivine gabbros and gabbronorites. Sulphides in Malola, Oncócua, and Lufinda are spatially associated with mica, suggesting sulphide melt segregation was associated with a hydrous and K-enriched interstitial melt. In Oncócua and Chiange, apatite is spatially associated with sulphides, suggesting late-stage crystallisation of sulphide melt from an evolved and potentially Fe-Ti-P-rich melt. EMPA analysis shows mica is phlogopitic and the apatite is fluoro-apatitic in composition, typical of mafic igneous rocks. Whole rock sulphur isotope compositions give mostly mantle-like $\delta^{34}S$ values (0 ± 2 ‰), suggesting minimal crustal sulphur input in Chibia, Chiange, and Lufinda. However, Oncócua displays slightly elevated $\delta^{34}S$ values (up to 3.43 ‰), suggesting the possibility of some crustal contamination associated with sulphur saturation.

Presentation Type:
Student Poster

Precambrian mafic dyke samples compilation – a new online GSWA dataset

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The Geological Survey of Western Australia (GSWA) regularly releases new and updated state-wide spatial datasets related to the geology and resources of Western Australia through its online mapping tool GeoVIEW.WA. Here we provide an overview of the ‘Precambrian mafic dyke samples compilation’ regional dataset that integrates GSWA and external analytical and geological information - and which will be released on GeoVIEW in 2026. This new data compilation complements the existing GeoVIEW 2.5M and 100k scale dolerite dykes’ layers, reconciling both dolerite dyke layers to coequal features and attributes. It focuses on the geochemistry of Proterozoic mafic dykes and sills, as well as providing a brief geological context, and includes both surface and drillhole samples. The new layer attributes are fully aligned with the stratigraphic systematic of the online ENS (Explanatory Notes System) of the GSWA. Data compilation and release will be completed progressively, with Stage 1 of the release covering the Yilgarn Craton, the Capricorn Orogen, parts of the Albany-Fraser Orogen, and the Pinjarra Orogen. The Stage 1 compilation combines 1165 georeferenced localities with variably detailed chemical analyses for 912 samples including multi-element and isotope geochemistry, available geochronology, analytical information, references on GSWA and external petrographic reports, and a few on palaeomagnetic studies. Around two thirds of samples have been assigned to 32 named suites and 4 unnamed lamprophyre groups based on age, orientation, magnetization, composition, and geological settings with ages ranging between 700 Ma and 2684 Ma. The rest of samples are attributed as Proterozoic or Archean. This dataset provides important information regarding mafic dyke classification, which enables the differentiation of unique emplacement events, magma sources, and related tectonic settings. Importantly, it also provides the context for additional systematic sampling and data collection where samples and/or data are currently missing.

Presentation Type:
Oral

Mantle metasomatism beneath eastern Australia and its role in mineral systems

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Mantle metasomatism is often invoked as an important but invisible process required for redistributing and concentrating metals into highly fusible regions of the mantle. This preconditions the mantle for subsequent partial melting of these metal-enriched regions, allowing the transport of metals from the mantle to form crustal-scale mineral deposits. The composition of the metasomatising agent(s) required for mobilising metals in the mantle and the composition of the resulting refertilised mantle phases are not well defined. Despite these gaps in our knowledge, metasomatism is thought to be essential for the development of mineral systems, but it is currently unknown how many mineral systems may be influenced.

We examine a suite of xenoliths from eastern Australia, providing a direct window into the mantle. These mantle xenoliths show a progressive metasomatic sequence with varying degrees of metasomatism, including abundant amphiboles and significant amounts of carbonates and sulfides. We demonstrate that multiple episodes of silicate- and carbonate-rich metasomatism have taken place that have refertilised the mantle with sulfides. This refertilised mantle predates the Eastern Australia Volcanic Province (EAVP) and may provide the metasomatised mantle source required for the range of compositions observed in the EAVP, as well as a mantle source for known mineralisation in the region.

Presentation Type:
Student Oral

Chromite control on IPGE and Rh in layered chromitites: Evidence from PGE fractionation in Cr-saturated magmas, Archean Sukinda Massif, India

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Mesoarchean chromitites from the Sukinda Massif (Singhbhum Craton, India) are among the oldest known stratiform chromitites formed in layered ultramafic–mafic intrusions. The deposit comprises multiple chromitite seams hosted by serpentinized dunite with subordinate orthopyroxenite, and has been linked to Cr-saturated, high-Mg parental melts with possible boninite affinity derived from a depleted mantle source. The chromitites display whole-rock PGE patterns strongly enriched in iridium-group PGE relative to palladium-group PGE, yet the magmatic processes responsible for this signature remain incompletely understood. To address this, we integrated whole-rock geochemistry, automated SEM-based mapping of platinum-group minerals (PGM), in situ LA–ICP–MS analyses of chromite, and chromite–olivine thermo-oxybarometry.

The Sukinda chromitites are essentially sulfide-free, indicating crystallization under sulfide-poor conditions. Microanalytical results show that PGE were partitioned principally between chromite and refractory Os–Ir-rich alloys. Chromite hosts most Ru and a substantial proportion of Rh, whereas Os and Ir are variably decoupled from chromite because they are also concentrated in Os–Ir–Ru alloys. This decoupling is strongest in the more reduced chromitites, where extremely low chromite Fe^{3+} contents and low calculated fO_2 [$\Delta \log fO_2$(FMQ) as low as –2] favored alloy stabilization. In contrast, marginally oxidized chromitites record weaker sequestration of Os and Ir into alloys and greater retention of these elements alongside Ru and Rh in chromite. Differences in whole-rock Cu/Zr ratios and total PGE contents between chromitite seams further indicate that the parental magmas differed in initial PGE tenor, possibly reflecting differences during mantle melting, including effects by sulfide sulfide, and/or transient sulfide stability during magma ascent and early differentiation. Collectively, our results show that chromite acted not merely as a trap for PGM, but as a major geochemical reservoir for IPGE and Rh. This challenges the common view that whole-rock PGE patterns in intrusive magmatic systems are governed primarily by sulfide or PGM accumulation, and highlights chromite itself as a key fractionating phase in Cr-saturated magmas.

Presentation Type:
Poster

Synergistic magma recharge and crustal contamination in the formation of the giant Xiarihamu Ni-Co deposit, Northern Tibet

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The Xiarihamu Ni-Co sulfide deposit in northern Tibet is the world's largest orogenic magmatic sulfide system. Mineralization is hosted in two spatially adjacent rock types (orthopyroxenite and harzburgite) which exhibit significant geochemical differences, indicating distinct magmatic and ore-forming processes. In this study, the compositional zonings in orthopyroxene crystals are analyzed using electron microprobe and secondary ion mass spectrometry, coupled with O-Nd isotopes and numerical modeling, to decipher the roles of magma recharge, siliceous crustal contamination and addition of external sulfur in deposit formation. Based on O-Nd isotopic mixing calculations, both rock types were derived from a mantle source metasomatized by sediment-derived melt and slab-derived fluid. However, the parental magma of pyroxenite underwent contamination by approximately 10% siliceous crustal material during its ascent, whereas the harzburgite experienced negligible contamination, which effectively explains their significant geochemical divergence. Orthopyroxene in orthopyroxenite displays oscillatory zoning in Cr-Ca-Fe, with $\delta^{18}O$ decreasing from cores (~6.7 ‰) to mantles (~6.2 ‰) and increasing at rims (~6.4 ‰), recording multiple magma pulse events. A crucial episode involving the recharge of primitive, Cr-Ca-rich magma during crystal mantle growth supplied the magma chamber with abundant ore-forming metals. Numerical modeling demonstrates that sulfide saturation in both rock types was triggered by assimilation of external sulfur from crustal granitic gneiss. Although high R-factors drive sulfur isotopes toward the mantle range and mask the true assimilation extent, they significantly enhance metal enrichment in sulfides. This study establishes a refined petrogenetic and metallogenic model for the Xiarihamu orogenic Ni-Co deposit, providing a critical framework for future exploration targeting.

Presentation Type:
Poster

Sulfide drainback in magmatic conduit system: insights from the Tulaergen Ni-Cu deposit, southern margin of Central Asian Orogenic belt, China

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The magma conduit model is fundamental to understanding the genesis of magmatic Ni-Cu sulfide deposits, however, the mechanism of downward sulfide transport—specifically, whether high-density sulfide melts can "drainback" into deep conduits—remains speculative and lacks precise geological constraints. This study reconstructs the evolution process of sulfide melt in the Tulaergen deposit in the Central Asian Orogenic Belt. The main orebody, situated in the upper-middle segment of the intrusion, exhibits anomalously low Ni/Cu ratios and homogenized trace element, in sharp contrast to the underlying, heterogeneous nature of the disseminated ores. This indicates that the massive and net-textured ores crystallized from a highly evolved sulfide melt that had undergone extensive monosulfide solid solution (MSS) fractionation. Our results reveal a marked discordance between the fractionated composition of the ore bodies and the high-flux physical environment of the deep-seated feeder conduit, which is unfavorable for the gravitational settling and in situ evolution of sulfide melt. Magma turbulence within the dynamic feeder conduit precludes a process involving in-situ fractionation. Instead, the melt appears to have drained back from the upper magma chamber. Quantitative 3D textural analysis further demonstrates that, unlike the high-sphericity, coalesced sulfides in the massive ores, the overlying net-textured sulfides possess significantly lower sphericity, larger specific surface areas, and channelized topologies. Specifically, massive ores represent the product of sulfide pooling, whereas net-textured ores record the hydraulic trapping of residual melt, effectively immobilized by capillary forces.

We propose a "Sulfide Melt Drainback" model, wherein primitive magma initially ascended to a shallow staging chamber, undergoing fractionation. Triggered by gravitational instability, the dense, evolved sulfide residual melt subsequently flowed downward along the feeder conduit. This model explains the emplacement of evolved sulfides within a deep conduit setting and highlights the critical role of physical transport in the final localization of high-grade mineralization.

Presentation Type:
Student Poster

Studies on cobalt-content in olivine as a tool for crystallization conditions of magmas

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Cobalt (Co) is a trace element constituent of olivine, and Co^{2+} replaces Mg^{2+} and Fe^{2+} in the M1 and M2 octahedral sites in the structure of olivine. While nickel (Ni) concentrations in olivine decrease rapidly with fractionation, in line with decreasing forsterite-content, Co concentrations are frequently observed to increase or remain stable, despite both elements exhibiting increased compatibility with cooling. This work constitutes a study of the occurrences of Co in grains of olivine collected from 9 locations in the USA spanning multiple tectonic settings and geologic provinces. For instance, troctolitic rocks from the Duluth Complex show a range of Co-content in olivine between 400 and 800 ppm, peridotitic rocks from Eagle and Tamarack intrusions in the Midcontinent Rift System lie in an intermediate range between 300 and 500 ppm and dunite-peridotite rocks from south-central Alaska such as Kenai and Eklutna Complex show a minimal content between 100 and 250 ppm.
We demonstrate that the high olivine-melt partition coefficient, D of Ni ~ 10 drives a steady and rapid reservoir depletion, whereas the low compatibility of Co with D ~ 4 allows the melt reservoir to be buffered by co-crystallizing phases such as chromite, clinopyroxene and plagioclase. While temperature, starting magma composition, degree of fractionation and oxygen fugacity are major controlling factors, the observed trends provide deeper insight into early crystallization behavior of magmas. The subtle differences in the compositional trends between Ni and Co in olivine, as conveniently expressed by the Ni/Co ratio, can be used as a sensitive indicator of magmatic processes such as fractional crystallization.

Presentation Type:
Poster

Metallogenic implications of the Xiarihamu No. II ultramafic intrusion-hosted Ni–Co sulfide deposit, East Kunlun Orogen

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Nickel (Ni) and cobalt (Co) are strategic critical metals. More than twenty mafic-ultramafic intrusions have been identified in the Xiarihamu area of the East Kunlun Orogen, where the superlarge Xiarihamu Ni-Co sulfide deposit is hosted by the No. I mafic-ultramafic intrusion. Characterized by Ni-Co enrichment and platinum-group elements (PGE) depletion, this deposit represents a significant ore deposit formed by large-scale magmatic enrichment of Ni and Co in an orogenic setting globally. The newly explored No. II mafic-ultramafic intrusion has reached a medium scale with a nickel metal reserve of 62,500 tons, and it is composed of four sub-intrusions, namely the II-1 to II-4. Its main mineralization age is constrained to 421~429 Ma, about 10 Ma younger than that of the No. I intrusion (410 Ma). This intrusion is distinguished by the enrichment of Ni, Co and PGEs, which challenges the prevailing inference that the district reflects PGE depletion in the magmatic source region.

The No. II intrusion is composed of peridotite, pyroxenite and gabbro, with pyroxenite being the dominant ore-bearing lithofacies. Nickel and cobalt occur in pentlandite, pyrrhotite, chalcopyrite, pyrite and a small amount of violarite as both solid-solution substitutions and discrete mineral phases; cobaltite is the independent mineral with the highest cobalt content, and PGEs are predominantly hosted in telluribismuthides (e.g., tetradymite). Cobalt content decreases progressively from the early-stage droplet-like pentlandite to the late-stage flame-like and nodular pentlandite. Part of the pyrite in the No. II intrusion has a hydrothermal origin, and violarite formed by the alteration of pentlandite is slightly enriched in Co during the hydrothermal alteration process. These observations indicate that sulfide liquid immiscibility, overprinted by hydrothermal upgrading, constitutes the core metallogenic mechanism for Ni and Co mineralization in this intrusion.

Presentation Type:
Student Poster

From Exploration to Discovery to Recovery

Session Convenors

Valentina Taranovic (Fortescue Metals)
Jon Hronsky (Western Mining Services)

International Symposium
on Mafic-Ultramafic
Mineral Systems
29 June – 03 July 2026 – Perth, Western Australia

Targeting large magmatic Ni-Cu discoveries from lithospheric fault controls

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Challenges to securing critical Ni and Cu metal supply include accurately predicting new discovery locations under cover. Most academic models for magma ascent ignore the role of translithospheric faults (TLFs). In contrast, many explorers invoke a TLF control on magmatic ore distribution but struggle to reliably map and target TLFs. Furthermore, published transtensional jog models for the emplacement of Ni-mineralised chonoliths at deposit scale are mostly wrong.

The role and predictive power of TLFs in localising large magmatic Ni-Cu (-Co, -PGE) sulfide deposits at subprovince, district, and prospect scales were tested with 72 global deposit case studies. At subprovince-corridor scale, most large Ni-Cu deposits occur in the hanging wall ≤30 km from a paleo craton edge-parallel TLF in a transtensional tectonic regime. At camp-scale, ~82 % of large deposits in intracratonic settings (not inverted pericratonic settings) are located ≤25 km from the nearest secondary transverse lithospheric fault, with half located within 5 km. Targeting the most prominent TLF intersections expands camp-scale footprints and reduces subprovince search areas (10,000s–100,000s km^2) to a few prospective camps (100s km2). Since large deposits are found closer to TLFs than small deposits, search criteria can be optimised for giant discoveries. Emplacement controls for mineralised channel-like flows and chonoliths are more stratigraphic than structural; where overpressured, high-temperature magmas self-generate pathways through rheologically weak and highly fusible metasedimentary or gneissic units.

A new bottom-up, self-organized, magmatic model is proposed where the root zones of TLF intersections channel ascending fertile mantle melts, and buoyant overpressured magmas are laterally dispersed (up to a few 10s km) through dike-sill-dike networks along hanging wall shortcut faults, their damage zones, and rheologically weak contacts. The extreme magma flux required to form large Ni-Cu sulfide deposits results from positive feedback between stress, heat and magma transfer, TLF strain partitioning, and intermittent coupling across transient rheological barriers.

Presentation Type:
Keynote

From mine to district: The current state of near mine exploration at Kevitsa

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The ultramafic Kevitsa intrusion hosts a sulphide-bearing, disseminated-style Ni-Cu-PGE deposit in the Central Lapland Greenstone Belt of Northern Finland (Sodankylä). The host rock for the pyrrhotite, pentlandite and chalcopyrite dominating ore body is an olivine-pyroxenite with both ortho- and clinopyroxenes. Kevitsa differs from most magmatic nickel deposits in terms of its disseminated style, unusually high metal tenors and its high Cu content. While current mine planning indicates production continuing to 2034, exploration remains active both in the near-mine area and across the broader district. The same exploration team is conducting both traditional near mine exploration close to the known deposit, supported by decades of drilling, mapping, geophysics, and geochemical dataset as well as green field exploration at distances of >50 km from the mine, where target generation must often proceed with more limited data and increasing emphasis on undercover and blind mineralisation. In the mature near mine setting, the key challenge is making reliable interpretations and effective synthesis from very heterogenous and colourful datasets to identify overlooked opportunities. This presentation provides a quick overview of the current exploration status, key activities and the principal challenges and opportunities for the exploration around Kevitsa mine.

Presentation Type:
Invited Oral

The Bangemall – a new mafic-hosted Cu-Ni-PGE Province

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The Proterozoic orogens of Western Australia host several Ni-Cu-PGE deposits including the Nebo-Babel deposits in the West Musgraves, the Nova-Bollinger deposit in the Albany Fraser Orogen and the Savannah deposit in the Halls Creek Orogen. Miramar Resources Limited (Miramar) has been exploring for Noril'sk-style Cu-Ni-PGE mineralisation within the Proterozoic Capricorn Orogen since 2020 and has made several significant technical advances in the last 12-18 months.

The Edmund and Collier Basins (formerly grouped together as the Bangemall Basin) lie between the Archean Yilgarn and Pilbara Cratons and were deposited between 1673 and 1075 Ma. The basins were intruded by three suites of dolerite dykes and/or sills including the 1070 Ma Kulkatharra Dolerite, part of the continent-scale Warakurna Large Igneous Province. Regional-scale regolith geochemical surveys conducted by the Geological Survey of Western Australia (GSWA) outlined Pd-Pt anomalies related to the Kulkatharra Dolerite sills.

In 2004, the GSWA recognised the potential for Noril'sk-style Cu-Ni-PGE mineralisation in the Bangemall sills through regional rock-chip sampling and analysis. Subsequent government seismic and airborne electromagnetic surveys increased the prospectivity for this style of mineralisation, but most previous explorers targeted sediment-hosted base metal mineralisation like the Abra deposit. Following a project-scale targeting exercise, Miramar applied for tenements over areas with Kulkatharra Dolerite sills, proximity to major crustal-scale faults and regional geochemical and/or geophysical anomalies.

Rock chip sampling traverses across outcropping dolerite sills at the Mount Vernon target identified evidence of differentiation, mafic cumulate rocks and disseminated sulphides for the first time. Subsequent airborne and ground electromagnetic surveys identified targets for drill testing, which was completed in 2024 and intersected differentiated dolerite sills including fine grained chill margins and coarse-grained gabbroic units. Use of the Micro-XRF technique in 2024-2025 confirmed the presence of olivine gabbro-norite and disseminated pentlandite and chalcopyrite in several holes, proving the Norilsk-style deposit concept in the Bangemall.

Presentation Type:
Oral

Updated stratigraphy and structural evolution of the Panton Complex, East Kimberley

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The Panton Complex, which hosts Australia's largest PGM deposit in the East Kimberley, is historically considered to be an isolated intrusion. However, observations indicate a dynamic system comprised of multiple magma pulses with different compositions and a regional structural trend that could have exploration implications across the East Kimberley.

Two distinct main ultramafic lithologies are present at Panton. The basal unit is comprised of negligible Pt-Pd anomalism and anomalous Ni-Cu-S confirmed by petrography and chemistry. The main reef hosting ultramafic, has highly anomalous Pt-Pd-Cr dispersed throughout the unit with Ni-Cu-S only associated with the main chromite reef mineralisation.

The relogging of historic drill core identified the presence of a 'mixing zone', up to 50m thick, which marks a period of hiatus between the two main ultramafic lithologies. A third ultramafic pulse is also identified and observed to be emplaced post solidification of the two main ultramafics and gabbroic lithologies that comprise the historic stratigraphy at Panton.

The geometry of the sill, which has been updated and modelled based on field mapping, hyperspectral and geophysical data reprocessing, has identified that the Panton Complex is a synform with a north-northeast to south-southwest orientation. The Panton synform is part of a larger folding event that includes Panton West, West McIntosh and Mini Intrusions. In particular, the Panton West ultramafic is the extremely thinned western side of the antiform. Along the NNE-SSW fold axis from Panton West is the Savannah Deposit which hosts 13.88 Mt 1.52% Ni, 0.69% Cu NS 0.10% Co.

This regional NNE-SSW structural orientation, combined with the revised stratigraphy at Panton suggest future potential within the East Kimberley, particularly by mapping the fertile zones based on the updated Panton stratigraphy and lithogeochemistry.

Presentation Type:
Oral

Late faults & Ni−Cu deposits: Is your chonolith fake?

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Over the last decade, important advances have been made on the geometry and dynamics of small km-scale intrusions that host orthomagmatic Ni-Cu mineralization. These typically exhibit irregular, non-tabular geometries that favour channelization of mineralized magmas. The term "chonolith", originally coined in the early 20th century to describe irregular intrusions at large, has been adopted by economic geologists for tube-shaped mineralized mafic intrusions.

Despite such advances, many deposits lack detailed structural characterization necessary to elucidate primary geometries and/or regional structural models. At Jinchuan, late E-W trending camp-scale faults, such as fault F16-1, are interpreted as sinistral strike-slip faults based on mapped horizontal separations. However, these may represent (at least partly) apparent offsets. Fault lineations observed on outcrop are oblique or parallel to dip. Moreover, the apparent sinistral offset of an ESE-striking, shallowly dipping syenogranite dyke can be explained by normal-dextral motion, and such kinematics are consistent with paleostress analysis of conjugate fracture sets in the vicinity of F16-1. At Voisey's Bay, some faults generate opposite apparent offsets suggestive of motion with a dip-slip component, and faults obscure the primary geometry of the Eastern Deeps deposit.

Nonetheless, post-emplacement faults have successfully been taken into account in some recent exploration efforts. The Inukshuk deposit, a blind deposit within the Expo (South Raglan) trend, was discovered due to apparent dextral offsets of the surrounding bladed dyke system. The offsets are due to post-emplacement, bedding-parallel, south-verging thrust faults that were subsequently folded. By taking such folded faults into account combined with applied geophysics (MLTEM), the Inukshuk deposit was discovered within the footwall of a thrust, in the core of a km-scale anticline. Dismemberment of Inukshuk by these faults produces near circular / irregular cross-sections akin to tubular chonoliths. Without (3D) structural constraints and holistic exploration models, dismembered dyke systems could easily be misinterpreted, and zones of sulfide accumulation potentially missed.

Validation of crustally-interpreted translithospheric faults as a proxy on prospectivity for discovery of intrusion-hosted Ni-Cu-PGE mineral systems in the West Yilgarn Magmatic Province, Yilgarn Craton - John Simmonds

Presentation Type:
Oral

Multi-mineral system investigation of the newly-defined Mons Greenstone Belt in the Youanmi Terrane, Yilgarn Craton

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Located 370km NE of Perth, mapping of the Mons area as dominant post-orogenic granite has been hindered by extremely limited outcrop and a complex regolith. Reinterpretation of regional geophysics, detailed magnetic, gravity, and EM surveys, regolith geochemistry and limited, mostly shallow drilling has confirmed the presence of a previously unidentified greenstone belt, interpreted to be the metamorphosed and tectonised roots of a two-stage stratigraphy.

The lower sequence (Stage 1) of highly deformed volcano-sediments is interpreted to be equivalent to 3.0-2.9 Ga greenstone that is widely distributed as inliers throughout the Youanmi Terrane. With metamorphic grade ranging from mid- to upper-amphibolite facies, greenstones are intruded by voluminous sheets of felsic pegmatite. Exploration targets are Ni sulphides in channel-facies komatiite, Cu-Zn bearing volcanogenic sediments and unusual zones of economically significant gallium-enrichment.

In the northeast, 330-oriented, doubly-plunging domes of Stage 1 greenstones and underlying gneiss-migmatite are intruded by mafic-ultramafic intrusives, aligned on 330-oriented parallel linears. While these intrusions are currently untested by drilling, structurally remobilised Ni-Cu sulphides in the Masson Dome strongly support a local provenance from one or more of these proximal intrusions. Compositional and textural analyses of the sulfide occurrences confirm their genetic association to a mafic melt, excluding an origin as remobilised sedimentary or hydrothermal sulphides. The presence of magmatic sulphide-matrix breccia and taxitic textures suggests that the mineralisation developed within a conduit-style mafic intrusion.

Stage 1 greenstones and mafic-ultramafic intrusions are unconformably overlain by a magnetically bland Stage 2 sequence that is interpreted to be equivalent to 2730 Ma felsic volcanic-volcaniclastic sediments and high-level intrusions of the Marda Volcanic Complex (located 35km E across the translithospheric Youanmi Fault) or metasediments of the <2746 Ma Mougooderra Formation. Within this weakly-disturbed basinal sequence, felsic intrusions and possible calderas are locally associated with Bi-Mo-W-As anomalies in Ultrafine regolith surveys.

Presentation Type:
Oral

Delineating new targets in a komatiite-hosted magmatic nickel sulfide prospect - Emu Lake, Kalpini, Western Australia

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This study tests the use of litho-geochemistry and indicator mineral analysis to delineate new exploration targets within the Emu Lake komatiite-hosted magmatic sulfide prospect within the Archean Eastern Goldfields Superterrane of Western Australia.

The Western Komatiite Belt (WKB) comprises several strongly altered komatiite-associated units, including the Eastern (WKB-EU), Central (WKB-CU), and Western (WKB-WU) Ultramafic. Massive sulfides have been intersected at the basal contact of the WKB-CU and WKB-WU units; however, the extent of this mineralisation is difficult to track along the ~15 km strike length of these ultramafic sequences due to multiple surrounding barren komatiite flows and significant fault offsets.

The WKB-CU and WKB-WU are chemically comparable, with compositions consistent with olivine mesocumulates, with low Cr_2O_3 contents over Mg# values of 85-93. The WKB-EU unit is chemically consistent with olivine-chromite orthocumulates, with high and variable Cr_2O_3 contents over Mg# values of 80-85.

Indicator minerals within the Emu Lake prospect consist of arsenides and chromite. Chromites within the WU have lower Ru contents than those within the other ultramafic units, suggesting crystallisation from sulfide-saturated magmas. Pd/Pt values of arsenides signify arsenic-rich fluids interacted with magmatic sulfide accumulation along shear or fault zones.

Surface samples collected above the mineralised area at the Emu Lake prospect contained sulfides (pentlandite and chalcopyrite). Primary sulfides sampled at the surface have the potential to be a powerful ex-situ indicator mineral and could be applied to magmatic sulfide exploration in greenfield terranes.

Prospective units can be distinguished using assay data and in conjunction with our new understanding of indicator minerals, further targets can be defined in the project area.

Presentation Type:
Oral

Geology and metal endowment of the Port Snettisham Ultramafic Complex, Southeast Alaska

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The U.S. Geological Survey is evaluating the lode critical-mineral potential of zoned ultramafic intrusions in southeast Alaska, where prior studies focused primarily on platinum-group elements (PGE). Given the economic importance of vanadium in Fe–Ti–V deposits such as those near Kachkanar (Urals, Russia), we investigated whether similar mineralization occurs in Alaskan Ural–Alaskan–type complexes and identified the Port Snettisham intrusion as a promising target. Port Snettisham is a Cretaceous ultramafic complex in the Yukon–Tanana terrane composed mainly of hornblende–magnetite–apatite clinopyroxenite, bordered by diorite to the south and metavolcanic rocks to the north. The intrusion is exposed over ~1.9 km^2, and geophysical data suggest it extends an additional 1.5 km to the northwest beneath Port Snettisham, yielding a total footprint of ~5 km^2 with unknown depth extent. Historically, the area was explored for gold, iron, and titanium. We present new bulk-rock geochemical data, including high-precision NiS fire-assay analyses of precious metals from 76 drill-core and surface samples. Bulk-rock V_2O_5 concentrations reach 0.41 wt % and average 0.15 wt %, while Pt+Pd+Au (3PGE) grades reach 341 ppb with an average of 46 ppb, Pd/Pt ≈ 1, and Cu/Ni ≈ 30. Vanadium is hosted primarily in disseminated to semi-massive magnetite, whereas PGEs occur as discrete mineral phases within silicates. Preliminary LA–ICP–MS analyses indicate magnetite contains up to 3,800 ppm V. An open-pit-constrained estimate of the mineralized material indicates approximately 285 Mt Fe, 42 Mt TiO_2, 2.6 Mt V_2O_5, 34.5 Mt P_2O_5, and 77.9 t 3PGE.

Presentation Type:
Oral

Petrophysical properties of rocks from the Kalatongke deposit and implications for exploration of magmatic sulfide systems

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Accurate geophysical interpretation requires quantitative petrophysical constraints that link geological heterogeneity to observed geophysical responses. However, the factors controlling petrophysical variability and their links to geochemical composition remain insufficiently constrained. Here, we present a comprehensive petrophysical dataset comprising density, magnetic susceptibility, and complex electrical resistivity for 1069 intrusive and wall-rock samples from the Kalatongke magmatic Cu–Ni deposit, China. These measurements are integrated with whole-rock geochemical data and evaluated using a supervised machine-learning approach to quantitatively assess the primary controls on petrophysical behavior. The results reveal systematic contrasts in petrophysical properties among ore types, barren mafic rocks, and wall rocks, with sulfide abundance emerging as the primary control on density, magnetic susceptibility, and resistivity. However, Devonian iron-rich tuffs exhibit magnetic susceptibilities comparable to those of mineralized mafic rocks, whereas Carboniferous C-rich tuffs display resistivities similar to those of moderately disseminated ores, introducing potential ambiguity in magmatic-electrical interpretations. Despite these overlaps, the multi-parameter classification model effectively discriminates ore-bearing rocks from barren mafic intrusions and wall rocks, achieving an overall classification accuracy of ~90 %. Furthermore, ore-related geochemical information can be inferred from petrophysical properties. Density and magnetic susceptibility can be reliably predicted from whole-rock chemical compositions, whereas electrical conductivity shows an indirect relationship with bulk chemistry. These results provide a quantitative framework for integrated geophysical–geochemical approaches in exploration and demonstrate the broader applicability of this approach to magmatic Cu–Ni and related mineral systems.

Presentation Type:
Student Oral

Validation of crustally-interpreted translithospheric faults as a proxy on prospectivity for discovery of intrusion-hosted Ni-Cu-PGE mineral systems in the West Yilgarn Magmatic Province, Yilgarn Craton

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For many mineral systems, critical components (metals, carrier fluid) are interpreted to be sourced from the base of the lithosphere, through direct partial mantle melting or remobilising previous metasomatic enrichment of the lithospheric mantle. Example systems include komatiite-hosted Ni-sulphides, many intrusion-hosted Ni−Cu sulphides, carbonatite REE and orogenic Au. Such lithospheric discontinuities can also provide access to magmas that are characterised as having a base of lithosphere origin. Examples are syenite, carbonatite, sanukitoid (including volcanics) and komatiite (including crust contaminated variants).

Identification of translithospheric discontinuities that potentially facilitated fluid and metal to upper crust emplacement is possible though analysis of crustal geology for C-TLF (crustally defined translithospheric faults) and mantle tomography or magnetotellurics for M-TLF (mantle defined TLF). This presentation examines evidence for C-TLF discontinuities that potentially channelled Ni-Cu-PGE mineral system emplacement through comparison with data on well-characterised granitoids, felsic volcanics, ultramafic intrusions and Ni-Cu mineral systems. Focus is on the ~ 2668 Ma West Yilgarn Magmatic Province that straddles the Southwest Terrane – Youanmi Terrane boundary.

Using an assumption of near-verticality for TLF, 6 km corridors are assigned to C-TLF and sections prioritized against evidence for translithospheric magma transit. These priorities provide a proxy on prospectivity for discovery of intrusion-hosted Ni-Cu-PGE systems in the West Yilgarn.

Presentation Type:
Poster

Ni−Co enrichment in the laterite deposits developed over ultramafic rocks in Indonesia

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The Ni-Co laterite deposit is widely distributed across Indonesia's central and eastern regions, which have propelled the country into a dominant nickel producer over the past five years. Its distribution is associated with the weathered peridotite rocks of the country's ophiolite complex. The deposit hosted two main ore zones: nickel-rich saprolite and the Ni-Co bearing limonite. This study aimed to investigate the Ni-Co laterite characteristics using samples from four major mines on the islands of Sulawesi and Halmahera to represent typical features of the deposits. The characteristics of the deposit are studied by combining ICP, XRD, SEM, TEM, and EPMA analyses of selected samples along the laterite profiles. Nickel concentration in the bedrocks varied from 0.2 to 0.4 % Ni, whilst Co content averaged 0.01 % Co and was mainly hosted by olivine and serpentine minerals. The latter is abundant in the saprolite zone and hosts a significant concentration of nickel, with an average grade of 1.55 % Ni, achieved by substituting Mg in the mineral structure with Ni. However, the highest Ni content is associated with the garnierite phase, which mainly occurs as veinlets or coatings in the lower part of the zone. Mineral assemblage in the limonite zone is dominated by goethite with minor occurrences of Mn-oxyhydroxide minerals, mainly found in the after saprolite-limonite boundary. Ni concentration in goethite varies from 0.5 % to 3 % Ni, whilst Co content is generally one-tenth that of Ni. Mn-oxyhydroxide minerals (a series of asbolane-lithiophorite and romanechite) hosted a significant concentration of Ni and Co, with the highest value reaching 9 % Co and 14 % Ni, respectively. In the romanechite, the Ni-Co concentration shows inverse correlation with Ba and K.

Presentation Type:
Student Poster

Below the Solidus – Secondary Enrichment and More

<u>Session Convenors</u>
Yoram Teitler (CSIRO)
Katy Evans (Curtin University)

Characterization of the Giant Jaguar Hydrothermal Ni-sulfide deposit, Carajás Mineral Province, Brazil

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The Jaguar Ni-sulfide deposit located within the Carajás Mineral Province of Brazil was discovered by Vale in 2007. The deposit was acquired by Centaurus Metals in 2019, who expanded the mineralized orebodies increasing the JORC Mineral Resource Estimate to 138.2 Mt @ 0.87% Ni; 1.2 Mt contained nickel, with a final investment decision expected to be announced in 2026.

The country rocks hosting the mineralization are 2.74 Ga subvolcanic dacite porphyry belonging to the regional volcanic-sedimentary sequence that hosts the giant iron ore deposits in Carajás, and 2.96Ga tonalite of the basement. Two large layered mafic-ultramafic intrusions (Onça and Puma) of the ca 2.74-2.76 Ga magmatic event in Carajás are located close to the ore deposits.

Nickel sulfide mineralization is hosted in mylonite zones within the regional Canaã Shear Zone. Progressive deformation and hydrothermal alteration result in chlorite-biotite and amphibole-magnetite alteration of the country rocks, developing robust alteration zones with strongly foliated to mylonitic fabrics. Hydrothermal alteration led to variable enrichment in Fe-K-P-F-Cl-LREE of pervasively altered country rocks.

The mineralization is mainly associated with magnetite-apatite bodies and consists of sulfide veins, stringers, breccias and minor massive bodies. The primary sulfide assemblage comprises pyrite, millerite, pentlandite, sphalerite and minor chalcopyrite and pyrrhotite. Secondary sulfides (e.g., violarite, polydymite, chalcocite, vaesite) are developed during oxidation replacement of the primary assemblage. The age of the mineralization system is not well constrained, but 2.2 Ga and 1.88 Ga ages of apatite indicate the importance of Paleoproterozoic events in the region.

It is postulated that Jaguar may represent a nickel-rich member of the regional hydrothermal system associated with IOCG-type deposits in Carajás. The occurrence of several mafic-ultramafic complexes (e.g., Onça, Puma, Vermelho) along the regional shear zones associated with IOCG-type and Ni hydrothermal deposits suggests that they correspond to the protoliths from which the hydrothermal Ni mineralization was sourced.

Presentation Type:
Invited Oral

Place and time of assimilation of wallrock in the Norilsk ore-bearing intrusions

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It is widely accepted that mantle-derived magmas are the primary sources and carriers of highly-siderophile and chalcophile metals to form the deposits in the crust. However, the environment of host sedimentary basins is no less important factor in ensuring a large volume of magmatic sulfides. New observations from the as yet unexploited Imangda deposit, located in the Devonian strata under the basalt cover on the western edge of the Tunguska syclinorium, provide solid evidence of contribution of sulfate-bearing dolomites to the formation of Cu-enriched sulfides and the increase in MgO whole rock content. An extent of assimilation of metasedimentary xenoliths in Norilsk picritic and taxitic gabbrodolerites is a matter of debates as textural and chemical consequences of their consumption are ambiguous due to their high degree or complete dissolution. The chemical, mineral and radiogenic isotope compositions of Imangda silicate rocks are identical to those of Talnakh and Kharaelakh whereas sulfides are distinguished by elevated ó34S values, which rise with decreasing metal tenor. Variations of Sr-in-plagioclase as well as changes in olivine morphology and compositions correlate with zones rich in xenolith's relics indicating the local character of contamination. MicroXRF mapping shows that xenolith's dissolution is accompanied by Mg, volatiles and S release into magma inducing local overcooling evident from the skeletal growth of silicates nearby. Magmatic degassing textures such as amygdules and segregation vesicles covered by chromite crystal shells, similar to those typical of the Norilsk-type upper series, are clearly associated with traceable layers of contaminated influxes. The Imangda sequence likely represents the root facies of the large-scale Norilsk magmatic plumbing system compared to the known ore-bearing intrusions of the frontal facies characterized by advanced digestion of assimilated material.

The study is supported by the Russian Scientific Foundation (grant 25-47-00051) and DSTI-NRF CIMERA (South Africa).

Presentation Type:
Keynote

High-temperature contact aureole of Norilsk type intrusions: mineral assemblages and implications for contact ore formation

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Sulfide ores of the Norilsk region are genetically and spatially linked to the differentiated gabbrodolerite intrusions, which emplacement triggered extensive metamorphic-metasomatic processes in surrounding rocks. The zoned contact-metamorphic aureoles comprise a specific Cu-rich (cuprous) ore type, which origin is debated. The highest-temperature of 700–1000 °C, which may promote sulfide melting, is reached in the zones of the spurrite $Ca_5(SiO_4)_2(CO_3)$-merwinite $Ca_3Mg(SiO_4)_2$ and pyroxene hornfels facies. The mineral assemblages of these facies are very rare in the Norilsk type aureoles and typically obscured by later low-temperature metasomatic overprinting. These contrast with the well-preserved mineralogy of rare high-temperature calcic hornfels associated with weakly mineralized intrusions of the Siberian trap province. Among such intrusions, the Tukalanda intrusion is located ~70 km southeast of the Norilsk 1 intrusion and emplaced into Lower Ordovician carbonate-dominated sedimentary rocks, forming a 50 m-wide contact-metamorphic aureole. The indicative minerals of high-temperature zones include merwinite, calcite, melilite-group minerals (gehlenite $Ca_2Al_2SiO_7$-akermanite $Ca_2MgSi_2O_7$), spurrite and monticellite with accessory spinel, perovskite, and Fe sulfides, whereas symplectites of spurrite and monticellite are crystallized at a regressive stage. The high-temperature mineral parageneses correspond to the well-constrained $CaO–MgO–SiO_2–CO_2–H_2O$ experimental system, indicating formation at 850–950 °C and pressures of 0.5–1 kbar. Calcic and associated magnesium skarns, oddly enough, form with an increasing distance from the contact. Hydrogarnets, serpentine- and chlorite-group minerals, secondary calcite, and calcium silicate hydrates replace primary associations. These observations help in reconstructing the PT-fluid regimes of the primary and secondary contact-metamorphic to metasomatic facies in the Norilsk ore region.

This research is supported by the Russian Science Foundation (grant 25-47-00051, https://rscf.ru/en/project/25-47-00051/).

Presentation Type:
Oral

Evidence for post-emplacement hydrochromatographic PGS mobility in the Merensky Reef, Bushveld Complex, South Africa, as a primary concentration mechanism

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The traditional models for the concentration of PGE-sulfides and PGE-TABS phases involve in situ precipitation, vertical settling and/or, less ‘popularly’, upwards compaction and buoyancy-driven migration, in interstitial melts, in fluid solution, or a combination of these. Evidence from wide-reef facies of the western limb of the Bushveld Complex indicates symmetrical distributions of PGE associated with the Merensky unit, as defined by a PGE-enrichment at top and bottom (rather than necessarily a chromitite layer, or a distinct pegmatoid, although both may be locally present). In addition, whole rock PGE abundances indicate that the footwall to the lower contact is distinctly depleted in PPGE, which are preferentially concentrated in sulfides, whereas the hanging wall is not, as should have been expected as a consequence of vertical settling and accumulation at horizons below. IPGE distributions are less strongly affected, consistent with mobility of PPGE by fractionation in a fluid or melt. The PGE are associated with remobilization as PGE-TABS phases associated with greenschist facies mineral assemblages in small veins adjacent to coarser sulfides. Sm−Nd whole-rock data indicate that the top and bottom reef-contact mineralized zones are represented by the least-evolved isotopic compositions, inconsistent with a model where chromite and PGE are precipitated in situ as a response to granitoid crustal contamination, although there is evidence of such contamination elsewhere in the reef sequence. A model of post-emplacement vertical mobilization of the PGE is proposed, with predominantly upwards-movement associated with the footwall in this case and overprinted by centimeter-scale scavenging of PGE from immediately above and below the eventual mineralized horizons, facilitated by aqueous fluids.

Presentation Type:
Oral

Formation of natural IrO_2 through Os–Ir–Ru alloy oxidation

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We studied a rare platinum-group element (PGE)-bearing phase occurring as inclusions in Pt–Fe alloys from placer deposits that has previously been referred to as “iridium oxide”, but without confirmation of actual Ir oxide. X-ray absorption spectroscopy demonstrates that the Ir–O phase is genuine IrO_2, with iridium in a formal oxidation state of 4+ and an Ir–O bond distance of 1.95 ± 0.02 Å, consistent with rutile-type IrO_2. Atom probe tomography shows that IrO_2 occurs as thin films along boundaries between metallic PGE-rich domains, which are separated by oxide-rich regions dominated by Ca, Mn, Fe, K, and V oxides. Mass-balance constraints indicate that Rh, Ru, and Pt reside mainly in metallic form, whereas Os is partly oxidized. Formation of IrO_2 from Os–Ir–Ru alloys requires extremely oxidizing conditions, estimated at approximately FMQ+5 to FMQ+10. Such conditions could potentially be achieved during hydrothermal alteration, yet geological evidence for these fO_2 values in natural systems is limited. The coexistence of IrO_2 with metallic Ru contradicts equilibrium thermodynamic expectations, which predict Ru oxidation prior to Ir. This discrepancy suggests that conventional equilibrium thermodynamics may not fully describe natural redox behaviour at the relevant scales, and that kinetically controlled reactions, very limited equilibrium length scales, or electrochemical work may enable localized Ir oxidation. These results provide rare in situ evidence for PGE oxidation and Os–Ir mobility in the lithosphere, with implications for PGE distribution and Os isotope systematics in mantle and crustal rocks.

Presentation Type:
Poster

Supergene redistribution of critical metals (Ni, Co, Cr, Sc, PGE) in the Sukinda chromitite–ultramafic complex, Odisha, India

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The Mesoarchean Sukinda chromitites and their serpentinised dunite–pyroxenite host rocks (Singhbhum Craton, India) have undergone intense lateritic weathering, forming profiles up to 70 m thick. This lateritisation has driven substantial redistribution and local enrichment of critical metals (Ni, Co, Sc, PGE), highlighting their potential for co-production alongside Cr, which is currently the main commodity mined. However, the processes controlling metal redistribution, ore geometry, and host-mineral evolution remain incompletely constrained.

The weathering profile records a typical ultramafic laterite evolution, progressing from Ni-enriched, Mg-silicate-rich saprolite to an oxide zone enriched in Ni, Co and Sc, and capped by a thick ferruginous duricrust that preserves evidence for both in situ induration and reworking–recementation. U–Th/He ages from goethite and hematite in both in situ and transported duricrust cluster at ~7 Ma, interpreted as a minimum age for lateritisation. Younger apparent ages (~0.5–2 Ma) likely reflect continued open-system resetting and/or He loss, consistent with prolonged weathering.

The saprolite is characterised by dissolution of primary silicates and formation of secondary Ni-serpentine, locally accompanied by silicification, before transitioning upwards into a goethite-dominated oxide zone. Nickel reaches highest concentrations in the upper saprolite (1.8 wt %), where it is hosted mainly in Ni-goethite and, to a lesser extent, Ni-serpentine and Ni-chlorite. Elevated Ni contents persist in the oxide zone (1.2–1.5 wt %), where it is hosted almost exclusively in Ni-goethite. Cobalt (800–1000 ppm) is concentrated in Mn-oxides within the lower oxide zone, whereas Sc is preferentially enriched in the upper oxide zone and duricrust, with goethite as its principal host. Higher Sc contents (up to 73 ppm) in pyroxenite-derived profiles reflect a strong primary lithological control, with enstatite representing the primary host. Chromite has been extensively dissolved, and Cr largely redistributed into goethite. In contrast, PGE are relatively immobile during weathering and remain residually enriched in both chromitite- and chromite-bearing dunite-derived profiles.

Overall, the Sukinda laterite closely resembles Ni–Co–Sc laterites in Indonesia and New Caledonia and illustrates how lateritisation of chromitite-bearing ultramafic systems can produce secondary polymetallic enrichment. These results highlight the potential to recover Ni, Co, and Sc from chromite mining waste through hydrometallurgical processing.

Presentation Type:
Poster

Mobilizing the immobile: The Avebury Ni-Co Deposit, Western Tasmania

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The mafic-ultramafic complexes of western Tasmania host the Avebury deposit, an atypical non-magmatic nickel sulfide and cobalt-bearing sulfarsenide system. Situated within the Zeehan mining district, the deposit comprises a resource of 293,000 metric tons of contained nickel at a grade of 0.9 %. The Avebury nickel deposit is hosted by Cambrian mafic-ultramafic rocks associated with allochthonous remnants of Early Cambrian back-arc ophiolites—interpreted as magma chamber cumulates parental to low-Ti tholeiitic basalts and high-Mg boninites—that were obducted onto Neoproterozoic rift sequences during the Middle Cambrian. Nickel sulfide mineralization comprises dominant pentlandite with subordinate pyrrhotite, magnetite, and minor chalcopyrite hosted by serpentinized dunite and peridotite cumulates, whereas peripheral cobalt-bearing sulfarsenides (cobaltite) are developed within a pyroxene-garnet-axinite-(Mg) ± ludwigite-tourmaline skarn halo at the contact with the Neoproterozoic sedimentary sequence. Hydrothermal fluids associated with the intrusion of the strongly fractionated, reduced, and Sn-mineralized Heemskirk Granite (ca. 360 Ma) drove the intense metasomatic overprint of the mafic-ultramafic and volcaniclastic rocks.

In contrast to regional Tasmanian mafic-ultramafic complexes that typically host Ir-Os-Ru alloys and Ru−(Ir−Os) sulfide and native platinum, the Avebury deposit is distinctly depleted in platinum group elements. Petrographic and microanalytical (SEM-EDS, AMICS−MLA, LA-ICP-MS) characterization of pentlandite, cobaltite, magnetite, and chromian spinel reveals a diagnostic geochemical signature enriched in W, Bi, Pb, Mo, Tl, Sn, Sb, and Zn. µXFM imaging identifies ruthenium concentrations at pentlandite grain margins versus depletion in chromian spinel, implying hydrothermal PGE mobilization. The decoupling of high nickel grades from Ir/Os ratios combined with the lithophile-element–enriched geochemical suite indicates formation via subsolidus processes rather than typical magmatic sulfide segregation. Consequently, the Avebury deposit is interpreted as the product of nickel remobilization from a precursor magmatic Ni-Cu-PGE system by high-temperature, fluorine-rich hydrothermal fluids evolved from the Heemskirk Granite.

Presentation Type:
Student Oral

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