2024 Howard Street Robinson Medalist

Professor Ali Polat (University of Windsor)

Dr. Ali Polat, a distinguished professor at the University of Windsor's School of the Environment, is an internationally recognized expert in geology. He specializes in the study of Archean greenstone belts, anorthosite-bearing layered intrusions, ophiolites, orogenic belts, and trace element and radiogenic isotope geochemistry. With a Ph.D. from the University of Saskatchewan and an M.Sc. from the University of Houston, Dr. Polat has built an impressive academic career, producing over 150 peer-reviewed journal articles, 8 book chapters, and presenting at numerous national and international conferences. His work has been widely cited, accumulating over 13,500 citations and earning him an H-index of 65 on Google Scholar.

Throughout his career, Dr. Polat has been recognized with numerous awards, including the W.W. Hutchison Medal from the Geological Association of Canada and the Outstanding Faculty Research Award from the University of Windsor. His contributions to the field have also earned him international awards, such as the Chang-Jiang Scholar Award in China and election to the Science Academy in Turkey. Dr. Polat has served as Co-Editor-in-Chief of Lithos and Editor-in-Chief of the Canadian Journal of Earth Sciences, contributing to the global geoscience community through both research and editorial leadership.

Prof. Polat was recently awarded the prestigious Howard Street Robinson Medal from the Geological Association of Canada in 2024. As part of this honor, he will be delivering lecture tours across Canada, sharing his insights into Archean geological processes and the mechanisms behind early continental growth.

Title 1: 'Formation of Archean Anorthosites at Convergent Plate Margins: Examples from Greenland and Canada'

Abstract: Anorthosites are plagioclase-dominant (>90%) igneous rocks and have formed in both oceanic and continental settings throughout the geological record, ranging in age from the Eoarchean to the Holocene. Despite their relatively small volumes in most orogenic belts, anorthosites are one of the most important rock types in the Earth's crust, recording key information for understanding igneous, crustal growth, and geodynamic processes throughout the geologic record. Archean anorthosites, spanning in age from 3950 to 2500 Ma, have unique mineralogical compositions, textural characteristics, microscopic to megacrystic (>40 cm) crystal sizes, are interlayered with genetically related mafic to ultramafic cumulates, and occur within contemporaneous tonalite-trondhjemite-granodiorite suites (TTGs) and greenstone belts. The Superior Province of Canada, the largest Archean terrain in the world, and the Greenland Craton contain the highest number of anorthosite occurrences among all Archean cratons on Earth. Archean anorthosites consist mainly of layered structures and megacrystic plagioclase, and are interlayered with leucogabbro, gabbro, peridotite, pyroxenite, hornblendite, and chromitite, and record greenschist- to granulite-facies metamorphism and poly-phase deformation. Because of their unique geological, lithological, mineralogical, geochemical, structural, and metamorphic characteristics, Archean anorthosites and associated rocks are of particular importance for unravelling magmatic, geodynamic, and crustal growth processes in the Archean. The presence of widespread magmatic hornblende in anorthosite-bearing layered intrusions in Greenland (e.g., Ivisaartoq, Fiskenaesset) and Canada (e.g., Mayville, Shawmere) is consistent with hydrous mantle sources. The geochemical compositions of the Mesoarchean Greenlandic and Neoarchean Canadian anorthosite-bearing layered intrusions are consistent with subduction-zone signatures, indicating that they originated from sub-arc mantle sources. These geochemical characteristics are also shared by the spatially and temporally associated TTGs and greenstone belts (mainly basaltic). Best documented Phanerozoic analogues of anorthosite-bearing Archean terrains include the Peruvian Andes, Fiordland (New Zealand), Kohistan arc (Pakistan), and Peninsular Ranges (California). In addition, Archean anorthosites share the mineralogical and geochemical compositions of anorthosites in Devonian to Paleocene Tethyan ophiolites, which predominantly formed at convergent plate margins and represent suture zones along which Tethys Ocean basins were closed. Collectively, in combination of whole-rock and zircon trace element signatures, depleted Nd isotope compositions, hydrous mantle sources, and macroscopic to regional scale compressional structures (e.g., asymmetric folds, thrust faults, overturned sequences) in Archean terrains consisting of anorthosite-bearing layered intrusions, TTGs, and greenstone belts reflect the growth of continental crust at convergent plate margins throughout the Archean.

Title 2: 'The Mechanism of Archean Continental Growth: Evidence from Field Relationships, and Volcanic Rock and TTG Geochemistry'

Abstract: Archean terrains consist predominantly (>90%) of contemporaneous tonalite-trondhjemite-granodiorite suites (TTGs) and greenstone belts, representing relict fragments of early continental crust. One of the most contentious areas of Earth Science today is the tectonic mechanism by which Archean continental crust was generated. Although studies on Archean terrains over the past four decades have enhanced our understanding of how these terrains formed, the nature of large-scale tectonic processes that produced Archean continental crust still remains highly controversial. This controversy and ongoing substantial debate have centered around opposing uniformitarian and non-uniformitarian tectonic models. The uniformitarian models propose that modern-style plate tectonic processes (e.g., subduction, accretion, collision) operated in the Archean, whereas the non-uniformitarian models postulate that vertical tectonics or other unknown processes (e.g., sagduction, catalytic delamination, heat pipe, mantle upwelling, stagnant lid) operated in the Archean. The question is which of these models is supported by the Archean rock record?

A review of the main lithological, structural, and geochemical data from 4.0 to 2.5 Ga Archean terrains reveals that they were generated at convergent plate boundaries by accretion of oceanic arcs, continental arcs, oceanic crust, and trench turbidites. Extensive geochemical data (>8,200 samples) from Eoarchean to

Neoarchean volcanic rocks plot mostly in the oceanic arc, continental arc, and back-arc fields in tectonic setting discrimination diagrams, which suggest that subduction-related geodynamic processes operated throughout the Archean. Similarly, a comparison of large trace element data (>3500 samples) from Eoarchean to Neoarchean TTGs with those from Phanerozoic arc TTGs (4100 samples) suggests that most Archean TTGs also formed in arc environments. The positive Pb and negative Nb anomalies of most Archean volcanic rocks and TTGs are fully consistent with subduction-related settings. The temporal variations in the incompatible trace element ratios of Archean volcanic rocks and TTGs, coupled with their lithological associations, demonstrate that intra-oceanic arc magmatism was prominent in the Eoarchean. The trace element systematics of Paleoarchean volcanic rocks and TTGs signify the beginning of Andean-style continental arc magmatism between 3.5 and 3.2 Ga. From ~ 3.2 Ga there was a gradual transition in intra-oceanic arc magmatism to more abundant Andean-type continental margin magmatism in the form of voluminous TTGs and sanukitoids. From 3.2 to 2.5 Ga juvenile oceanic crust and arcs continued to form, accompanied by more active continental margin magmatism until 2.7-2.5 Ga, by which time there were sufficient crustal rocks to amalgamate into incipient large continents, the fragmentation of which started the first complete classical Wilson Cycle Plate Tectonics of breaking apart and re-assembling large continental masses. Field evidence for uniformitarian tectonic processes in the Archean rock record is exuberant, whereas field evidence to support the non-uniformitarian models is lacking.