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Naviguer les changements du passé et de l'avenir

Judi Pennanen, water colour / aquarelle, 56 cm x 75 cm

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ite, quartz syenite, and peralkaline granite. Marble and various calc-silicates are located along the contact between the Kipawa complex and the 2.7 Ga Kikwissi (granodiorite and tonalite). As compiled from the literature and our results, the identified rare minerals from the Kipawa region include: alkali and or calcic zirconosilicates (eudialyte, vlasovite, mosandrite, gittinsite, hiortdahlite, allanite), fluorocarbonate (britholite, fluorite, bastnaesite), phosphate (monazite, xenotime), oxide and other silicates (agrellite, miserite, pectolite, zircon, thorite). Four main REE-Y-Zr zones are known at the main deposit (Sheffield): eudialyte, mosandrite, britholite, vlasovite.

Syenites and alkali granites from the Sheffield deposit have similar chondrite-normalized REE profiles characterized by pronounced negative Eu anomalies (Eu/Eu*=0.4). Ratio of Eu/Eu* remains constant with the increase in SiO_2 or Al_2O_3 and the decrease of CaO suggesting that the fractionation of plagioclase was not significant. Bird-wing patterns with relatively high normalized values for the lightest and heaviest elements (La, Yb-Lu) also occur. Primitive mantle normalized profiles show systematic prominent negative K, P, Ti, Eu anomalies and positive Zr anomalies. A strong positive correlation between whole rock content of fluoride and REE suggest that the involvement of metasomatic fluids combined with the high degree of fractionation of the syenite magma were key aspects in the transport and concentration processes for this REE system.

Wu et al. (2010) reported laser ICP-MS analyses of eudialyte from the Sheffield deposit which provided a U-Pb age of 1012 ±16 Ma, similar within error to TIMS results for zircon from the peralkaline skarn (994 ±2 Ma; vanBreemen and Curry 2004). This eudialyte with an isotope composition of $\varepsilon_{Nd(t)}$ = -10.64, indicate a geochemical signature akin to partial melting of an enriched mantle source and/or mixing with fluids derived from melting of the over-thickened lower continental crust during the Grenvillian orogeny.

$^{40}Ar/^{39}Ar$ INVESTIGATION OF THE OTTER LAKE REGION, QC, CENTRAL METASEDIMENTARY BELT, GRENVILLE PROVINCE

Cope, N.J.[1], ncope1@kent.edu, Schneider, D.A.[2], and Holm, D.K.[1], [1]Department of Geology, Kent State University, Kent, OH 44242; [2]Department of Earth Science, University of Ottawa, ON K1N 6N5

Convergence during the Grenville orogeny led to crustal thickening and juxtaposition of the currently shallow southeast-dipping imbricated terranes of the Central Metasedimentary Belt (CMB). Subsequent crustal thinning during post-orogenic collapse was likely accommodated along shear zones that were reactivated during extension. The Mont Laurier terrane of the CMB in Quebec contains intercalated Paleoproterozoic gneiss, marble, amphibolite, and quartzite units that originate from upper amphibolite to granulite facies metamorphism of a back-arc sequence. In the Otter Lake region, the terrane is divided into the Marble (west) and Quartzite (east) Domains, separated by southeast dipping Heney deformation zone (HDZ). We performed $^{40}Ar/^{39}Ar$ thermochronology on a suite of samples, which were collected on a broad transect across the HDZ. Similar thermochronologic investigations conducted in the southern CMB (of Ontario) record cooling ages which young to the east across domains, with marked increases in cooling ages immediate east of shear zones separating the domains. From the Otter Lake region, mineral separates were obtained from garnet-biotite, biotite-plagioclase, and potassium feldspar gneisses, amphibolites and metagabbros, and a marble containing subvertical relict sedimentary bedding. Most samples are pervasively deformed, with fine- to medium-grained biotite defining the foliation fabric; amphiboles exhibit little to no alignment, and are relatively inclusion-free. In the samples from which mineral separates were taken, deformational features include some sutured and bulging quartz grains, subgrain development, and the brittle deformation of garnet in one sample. Preliminary $^{40}Ar/^{39}Ar$ analyses yield generally well-behaved age spectra with antithetic Ca/K spectra exhibiting full or near plateaux. East of the HDZ, hornblende ages are ca. 1145 Ma and (euhedral) phlogopite ages are ca. 1120 Ma, whereas west of the shear zone hornblende ages are markedly younger (ca. 890-930 Ma) and similar to biotite ages from this region (ca. 885-905 Ma). Initial interpretation of the $^{40}Ar/^{39}Ar$ mineral ages considers early exhumation of the Quartzite Domain during collision resulting from thrusting along the HDZ, and younger mineral ages from the Marble Domain as subsequent (dynamically recrystallized) resetting or later exhumation during extensional reactivation of the HDZ.

THE DEVELOPMENT OF THE NORTH MARGIN OF THE NORTH CARIBOU TERRANE THROUGH THE NEOARCHEAN, BUILDING THE FOUNDATION FOR LODE GOLD MINERALIZATION

Corkery, M.T., timothy.corkery@gov.mb.ca, Manitoba Geological Survey, 360 1395 Ellice Ave., Winnipeg, MB R3G 3P2, Parks, J., jen.parks@sciborg.uwaterloo.ca, and Lin, S., shoufa@uwaterloo.ca, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, ON N2L 3G1

Fault bounded crustal blocks record a complex history of geologic development for the northern margin of the North Caribou Terrane in Manitoba and Northwestern Ontario. Bedrock mapping and structural, geochemical, geochronological and isotopic research in the northwestern Superior Province of Manitoba reveal a complex geologic history of the margin of small continental landmass between ca. 3.0 and 2.7 Ga. Cyclical periods of rifting and the formation of back arc basins, alternating with basin closure and suturing, have been documented. The basin closure was followed by post collisional crustal adjustment concomitant with periods of metamorphism on the craton. These events produced a fertile structural and lithological framework for formation of lode gold mineralization. Subsequent collision with the 3.6 Ga. Hudson Bay Terrane at circa 2.7 Ga left the remnants of a juvenile oceanic basin, the Oxford Stull Domain along the north margin of the North Caribou Terrane. The pre-existing sutures in the North Caribou Terrane and newly formed sutures formed in the collision with the Hudson Bay Terrane provided the framework for an extensive anastomosing set of transpressional shear zones that are now the locus of numerous gold occurrences. These sutures formed crustal scale zones of weakness that provided pathways for mineralizing fluids to migrate upward to pressure temperature regimes conducive to gold deposition. The regionally extensive anastomosing network of transpressive shear zones thus provided the physical traps for an extensive region of lode gold mineralization. It is entirely possible that more than one mineralizing event occurred in the North Caribou Terrane, however, geological evidence indicates post 2.7 Ga mineralization occurred in the juvenile Oxford Stull Domain along the Stull-Wunnummin transpression zones.

MINAS DE CAMAQUÃ (RIO GRANDE DO SUL, BRAZIL): ALSO AN IOCG-TYPE DEPOSIT?

Corrêa de Abreu, G.C., gustavo.abreu@usp.br, Caramello, F.C., fernando.caramello@usp.br, and Garda, G.M., Instituto de Geociencias da USP, Rua do Lago 562, 05508-080-Sao Paulo, SP, Brazil, giagarda@usp.br

After the formation of the Gondwana Supercontinent, rift-type basins associated with ENE-NNE-trending faults were installed in the central-southern region of the State of Rio Grande do Sul (Brazil). The Camaquã Basin, cropping out in an area of more than 3200 km^2 in the Riograndense Shield, is the most conspicuous and is composed of a large variety of continental and coastal sediments

and volcanic rocks associated with A-type granites. Minas do Camaquã, located in the central part of the Camaquã Basin, has the best expositions of the Santa Bárbara Group, which represents the Ediacaran sedimentation of the Camaquã Supergroup, according to the most recent stratigraphic evaluation.

Minas do Camaquã host major base-metal deposits, which are in direct association with a major fault system that crosscut the sedimentary bedding. The ores occur as massive veins, stockworks, and disseminated ores. Exploited for more than 100 years, Minas do Camaquã stopped operating in 1996. Before exhaustion, the ore reserves were 30.8 million tonnes, averaging 1.06% Cu, with Au and Ag as the main byproducts.

Recent lithological-structural mapping of three open pits (namely Uruguai, Piritas and Intermediária) showed that the ores are preferably concentrated in NW-trending, SW-dipping faults and fractures, which are variably mineralized in Au-bearing platy hematite (specularite intergrown with quartz), Cu sulfides and barite. Previous underground works carried out in the neighboring São Luiz mine indicated that the NW-trending faults are perpendicular to oblique in relation to the N30-40E-trending faults of the Irapuá System. Mineralization was also stratigraphically controlled, as it is hosted by the Seival and Rincão dos Mouras Formations, composed of shoreface sandstones and siltites, and fluvial/alluvial sandstones and conglomerates, respectively.

The ore mineral assemblages include chalcopyrite, pyrite, bornite, chalcocite, gold, silver, and hematite. Preliminary MEV-EDS analyses revealed the presence of Bi-Cu-(Ag) sulfides associated with chalcopyrite. Gangue minerals, such as chlorite, K-feldspar, sericite, quartz, carbonate and barite, characterize hydrothermal alteration haloes, which are more intense in the vicinities of the faults and fractures.

A magmatic hydrothermal origin for the Camaquã deposit has been proposed by previous works. Because of the similarity of style of mineralization and hydrothermal alteration with the some deposits of the Proterozoic Tennant Creek district of the Northern Territory (Australia), we propose that at least part of the mineralization (characterized by hematite, chalcopyrite, gold, Bi-Cu-(Ag) sulfides and associated with chlorite, sericite, quartz, carbonate and barite) if of the IOCG-type.

PRECAMBRIAN GEOLOGY OF MELVILLE PENINSULA, NUNAVUT: A WINDOW ON THE EVOLUTION OF THE WESTERN CHURCHILL PROVINCE

Corrigan, D.[1], dcorriga@NRCan.gc.ca, Nadeau, L.[2] and Wodicka, N.[1], [1]Geological Survey of Canada, 601 Booth Street, Ottawa, ON K1A 0E8; [2]490 de la Couronne, Québec, QC G1K 9A9

The Western Churchill Province (WCP) forms a collage of Archean crustal blocks with Proterozoic supracrustal sequences, mafic dykes and plutonic suites that were variably reworked in the interval ca. 1.90-1.80 Ga, during the final assembly of the Supercontinent Nuna. Melville Peninsula provides a well-exposed section through the central-eastern Rae Craton, one of the largest pieces of the WCP mosaic. The section exposes from north to south i) a Mesoproterozoic continental rift sequence (Fury and Hecla Formation) and associated E-W brittle normal faults, ii) a granulite facies terrane dominated by metaplutonic rocks of yet unknown –but likely NeoArchean– age, iii) Meso- to Neo-Archean age, de facto Rae crust, iv) two Paleoproterozoic supracrustal sequences (Penrhyn Group and Folster Lake Formation), v) a zone of localized ductile transpression with a dextral slip component (Lyon Inlet Boundary Zone), and vi) presumably Archean-age orthogneiss with an anhydrous, orthopyroxene-bearing plutonic suite and a granulite facies cover sequence of marble and metapelite, of likely Proterozoic age (Repulse Bay Block). The Rae crust consists of isolated strands of upper-greenschist to middle-amphibolite facies Archean volcano-sedimentary belts intruded by, and separated by, ca. 2.76 to 2.60 Ga plutonic rocks of predominantly monzogranitic composition. The Archean supracrustal belts, collectively referred to in the literature as the Prince Albert Group, appear to form remnants of volcanic, volcaniclastic and associated sedimentary rocks, with internal unconformities suggesting complex histories. Preliminary U-Pb age determinations on zircon suggest that two of the largest greenstone belts, the Prince Albert Belt (new name) to the west and Roche Bay Belt (new name) to the east, are separated in age by about 200 m.y. However, similar Nd model ages of about 2.9 to 3.2 Ga on plutonic components of both belts suggest a common source and potential affinities with the Mesoarchean Mary River Group on Baffin Island. These ages also suggest a separate evolution from the younger (ca. 2.73-2.71 Ga), Meadowbank and Committee Bay belts that occur further to the southwest. The Paleoproterozoic Penrhyn Group hosts sedimentary strata that appear to indicate an evolution from intracratonic platform to continental margin anoxic or restricted circulation basins that are overlain by thick greywacke-turbidites. North of the Penrhyn Group, the subgreenschist facies Folster Lake Formation may represent remnants of a foreland flysch or molasse basin deposited during the peak of Trans-Hudson Orogeny. Its relatively low grade metamorphic overprint and moderate deformation may provide a northwestern limit for Hudsonian tectonothermal overprint.

THE IOCG ALTERATION TO BRECCIATION AND MINERALIZATION ZONING MODEL – A VECTOR TO MINERALIZATION TESTED IN THE GREAT BEAR MAGMATIC ZONE, NWT

Corriveau, L., Geological Survey of Canada, GSC-Québec, 490 de la Couronne, Québec, QC G1K 9A9, lcorrive@nrcan.gc.ca, and Montreuil, J-F., INRS-ETE, 490 de la Couronne, Québec, QC G1K 9A9

A conceptual alteration to brecciation and mineralization zoning model that frames the development of iron oxide-apatite, magnetite- and hematite-group iron oxide copper-gold (IOCG) and associated skarn deposits is proving to be a powerful predictive tool for mineral exploration and regional mapping in under-explored and under-mapped terrains. Under the Geomapping for Energy and Minerals (GEM) program, the systematics of alteration and evolution of brecciation were used in the significantly under-explored Great Bear magmatic zone (NWT) to 1) recognize new IOCG systems, 2) validate the model and continuity with other deposit types at known showings and past-producing mines, 3) infer maturity and potential fertility of identified systems, and 4) vector towards mineralization.

One of the case studies centres on the 31 Mt Au-Co-Bi-Cu NICO deposit. Here, magnetite-group IOCG ore is associated with a cyclical build-up of high-temperature calcic-iron and potassic-iron (magnetite) alteration below an unconformity (stages 2 and 3 of the model). The extensive early sodic alteration that provides nutrients for IOCG systems (stage 1) and the low temperature potassic-iron (hematite) alteration, plus uranium/REE mineralization and silicification that should have formed through the cyclical outflow of remaining fluids and elements (stages 5 and 6) had not been observed. Systematic alteration mapping away from the deposit led to the discovery of a 2 by 0.5 km structural breccia corridor with syn- to post-tectonic hydrothermal iron oxide (magnetite to hematite) replacement-style alteration, breccias and veins, and U-Th-arsenopyrite±molybdenite anomalies within sodic-, potassic- or silica-altered metasedimentary rocks. This system records cyclical build up of alteration stages 5 and 6 within albitite (stage 1). Strain partitioning between the overlying mas-