A multidisciplinary approach to detect multiple source reservoirs and processes in the formation of turbidite-hosted gold mineralization: an example from the Meguma Terrane of Nova Scotia

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Meguma lode-gold deposits (historical production 1.2 million oz.) are vein-type mesothermal deposits hosted by metasedimentary rocks of the Lower Paleozoic Meguma Group (Nd model age 1.6 Ga) of southern Nova Scotia. High-grade ortho- and paragneisses, with model Nd ages of ca. 1 Ga, are restricted to the central Meguma Terrane (Liscomb area), record emplacement at ca. 380 Ma ($^{40}Ar/^{39}Ar$ ages) and contain xenoliths of deformed Meguma Group lithologies. The Meguma Group and overlying Silurian-Devonian volcanic sedimentary rocks were deformed during the Acadian Orogeny (ca. 400 Ma) which records the docking of the Meguma Terrane with Avalonia or ancestral North America. The Meguma Group and Liscomb gneisses were subsequently intruded at ca. 370 Ma by peraluminous granites and temporally related gabbros and mafic dykes (lamprophyres), the latter of which contain granulite-facies xenoliths (14 kbars, 1000°C) of Avalonian heritage with Nd model ages of 600 Ma. It is within this setting that the Meguma gold deposits formed.

The gold deposits occur throughout the basal, sandstone dominant part of the Meguma Group (Goldenville Formation) and are found in both greenschist and amphibolite facies rocks. Deposits generally occur in domal structures with veins favouring steep to overturned southern, limbs. Most deposits consist of numerous bedding concordant veins with lesser discordant type veins; saddle reefs (*sensu stricto*) and ac veins are rare (e.g., Dufferin and West Gore, respectively). Vein structures suggest emplacement into brittle/ductile shear environments of subvertical orientation (i.e., subvertical mineral lineations) within which the mean principal stress axes rotated (e.g., δ_1 flat to sub-vertical) and fluid over-pressuring occurred. Wallrock alteration is cryptic to intensely developed, with silicification, sulphidization, carbonatization and sericitization the most common. Veins are dominated by quartz, carbonate and sulphides, but a wide variety of accessory minerals occur, locally forming pegmatoid veins (amphibole-plagioclase-biotite-tourmaline-apatite). The chemistry of vein minerals [e.g., Fe/(Fe+Mg) of mica] indicate fluids were wall rock-bufferred and indicate peak temperatures of ca. 350 to 500°C. Veining is constrained to ca. 370 ± 8 Ma based on $^{40}Ar/^{39}Ar$ dating of vein minerals which agrees with field relationships in deposits found within the contact aureoles of 370 Ma granites. Recently, vein-free types of gold mineralization have been found associated with zones of carbonate and sericite alteration.

Fluid inclusion studies indicate the vein fluids were low-salinity H_2O-CO_2-NaCl type, record a large range in P_{fluid} (≤1 to 6.5 kbars), suggest over-pressuring was common, and that fluid unmixing was rare (West Gore, Tangier). All vein types have similar inclusion types and chemistry (thermometric and gas chemistry). Isotopic data (C, S) record interaction of the vein fluids with Meguma Group lithologies and local derivation of reduced carbon and sulphur. Isotopes of O ($\delta^{18}O_{fluid}$ = 8-12‰) and D (-40 to -60‰) are most consistent with a metamorphic origin, with some overlap into the magmatic field. Strontium isotopes for vein carbonates and tourmaline indicate a mixed reservoir, one of which must be non-Meguma Group (i.e., Sr_I<0.712 at 370 Ma). However, when the Sr isotope data are combined with Pb isotope data for vein galena the Liscomb Gneisses can be finger printed as the sole reservoir. These data are consistent with REE data for vein carbonates that show a wide range in ΣREE and fractionation, again suggesting multiple reservoirs.

This multidisciplinary study indicates that the fluids which formed the Meguma gold deposits are generally not unique geochemically, but instead owe their origin to a variety of processes from the time they were generated deep within the crust until they precipitated as vein material within brittle/ductile shear zones. Interaction of the fluids with wall rocks during their passage through the crust has resulted in the inheritance of many geochemical signatures, all of which bear witness to this interaction. Recognition of such camouflaging is important when discussing sources of fluids or metals, and genetic models.