Evidence For Pre- to Syn-Timiskaming Hydrothermal Activity, Abitibi Greenstone Belt, Canada

Gregory Hufford* and Thomas Monecke

Department of Geology and Geological Engineering, Colorado School of Mines, 1516 Illinois Street, Golden, Colorado 80401

*E-mail, ghufford@mines.edu

The Neoarchean Abitibi greenstone belt of Ontario and Quebec is one of the world's most prolific precious metal provinces. It consists of a collage of east-trending successions of volcanic strata that were formed between 2750 and 2695 Ma. In the southern part of the belt, a change in depositional setting is recorded by the widespread subaqueous deposition of 2690 and 2685 Ma fine-grained clastic rocks derived from an eroding hinterland. These deposits are separated by an angular unconformity from the younger sedimentary and volcanic rocks of the 2676 and 2670 Ma Timiskaming assemblage. Formation of the dominantly subaerial deposits of this assemblage occurred in response to a period of crustal thickening and mountain building. The Timiskaming assemblage is exposed primarily along the crustal-scale Porcupine-Destor and Larder Lake-Cadillac fault zones and represents the principal host to orogenic gold deposits in the Abitibi belt.

Previous research in the Abitibi belt has established that the main phase of hydrothermal activity resulting in the formation of orogenic gold deposits significantly postdated the Timiskaming assemblage. Only limited evidence points to pre-Timiskaming hydrothermal activity that can be related to the phase of crustal thickening and mountain building between ca. 2685 and 2676 Ma. Most notable are rare clasts of carbonate vein material within subaerial conglomerates of the Timiskaming assemblage. In addition to the carbonate vein material, quartz clasts occur throughout the Timiskaming assemblage. These quartz clasts may have been derived from eroding quartz veins or coarse-grained igneous or metamorphic sources.

To provide additional constraints on the origin of the quartz clasts, an array of texturally diverse clasts were sampled from the Timmins, Kirkland Lake, Duparquet, and Rouyn-Noranda areas. The collected clasts range from those entirely composed of massive white to milky quartz to previously undocumented clasts of igneous rocks that are crosscut by quartz veins truncated at the clast margins. Microscopic investigations show that the quartz in these clasts has typically been affected by extensive recrystallization. In many cases, the clasts consist of polycrystalline quartz exhibiting irregular grain boundaries formed by pervasive recrystallization. Individual quartz grains are crosscut by myriad wispy trails of secondary fluid inclusions, many of which exhibit visible CO_2 at room temperature. These inclusion trails are interpreted to have formed as a result of the post-depositional metamorphic overprint of the quartz clasts. Only few clasts contain euhedral quartz crystals that have not been entirely recrystallized. The euhedral quartz crystals show blue to yellow cathodoluminescence colors and contain low-temperature primary fluid inclusions. These properties are consistent with the quartz being derived from hydrothermal vein quartz, not unlike quartz in epithermal deposits or orogenic deposits formed in shallow crustal settings.

Although the origin of most quartz clasts cannot be determined unequivocally due to the effects of recrystallization, the observed relict euhedral quartz crystals present in some clasts are indicative of the existence of pre- to syn-Timiskaming hydrothermal activity. This finding has important implications for metallogenic models of the Neoarchean Abitibi greenstone belt.