Zircon and Melt Inclusion Geochemistry from the 1.1 Ga Jogran Porphyry, Canada: Implications for Porphyry Formation in a Non-Arc Setting

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The Jogran quartz-monzonite porphyry (20 million tonnes @ 0.19%Cu), is one of a series of Cu-mineralized intrusions located near Mamainse Point, Ontario, Canada, on the northeastern shoulder of the ~1.1 Ga Midcontinent Rift System (MRS), hosts unique porphyry-style Cu-(Mo) mineralization in an intra-plate, rift-related large igneous province setting. A new high precision 206Pb/238U zircon age of 1090.90 ± 0.35 Ma (CA-TIMS) constrains the formation of the Jogran porphyry to the waning of the main Rift Stage (1102-1090 Ma) and transition to the Late-Rift stage (1090-1083 Ma). Zircon geothermometry and oxybarometry indicate crystallisation conditions of 900-670 °C and a fO2 range of ΔFMQ = -1.3 to +0.6. As temperatures decrease, ΔFMQ values increase along a trend subparallel to the SO_2-H_2S buffer. The presence of sulfide inclusions in zircon, confirms sulfide saturation during crystallization.

The zircon crystals display an increase in [Yb/Gd]n ratios and depletion in Th/U (1.0-0.4) in the rims relative to the cores consistent with single stage fractionation and crystallisation upon emplacement. Melt inclusions (MIs) range in composition from 65-70 wt.% SiO_2 with 5.5-8.3 wt.% K_2O and K_2O/Na_2O ratios of ~1.5-3.5, suggesting the parental melt was alkalic to shoshonitic. Low Cs concentrations, coupled with high Rb, Ba, and Nb, in MIs indicate minimal crystal fractionation of a near-primitive, mantle-derived composition. In contrast, whole-rock data show lower alkali contents (4.0 wt.% K2O) and have a subalkalic affinity, suggesting crustal contamination or alteration obscured the primitive magmatic signature.

Felsic magmatism and porphyry-style mineralization at Jogran occurred during maximum lithospheric weakening/crustal thinning during the shift from extensional tectonics to thermal subsidence in the late stages of the MRS. Although small, Jogran highlights the potential for porphyry-style mineralisation in non-subduction tectonic contexts and underscores the need to better understand metallogenic pathways beyond the traditional subduction models.