A Long Lived Mega-Hydrothermal System Preserved in the Granophyre Unit of the 1.85 Ga Sudbury Impact-Generated Melt Sheet Ontario, Canada

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Abstract

The Sudbury Igneous Complex (SIC) is a differentiated impact melt sheet and part of the mineralizing environment of one of the largest Ni-(Cu-PGE) districts globally. The upper 1.5 km of the 2.5 km thick crystallized melt sheet, referred to as the granophyre unit, consists of amphibole (north range) or biotite (south range) – a two-feldspar (i.e., subsolvus) monzogranite characterized by variably developed granophyric texture (0-60 vol. %). We summarize below the results of a detailed textural and mineral chemical study of the granophyre. This information collectively demonstrate the pervasive re-equilibration of this unit with moderate-to low-temperature fluids during cooling of the SIC and collapse of its hydrothermal systems: (1) feldspar phases (50-70 vol. %; Ab_{95-100} and Or_{95-100}) record equilibration to <350ºC); (2) both feldspars are strongly pitted, a texture indicative of dissolution-reprecipitation reactions; (3) amphibole (*mg* = 0.57–0.69) is extensively replaced by secondary, locally pit-textured, Fe-rich (*mg* = 0.15-0.29) amphibole phases; (4) CL imaging of quartz reflects little to extensive re-equilibration with fluids; (5) two types of secondary fluid inclusions occur in quartz, one with T_h values of 320ºC and 23 wt.% eq. NaCl and the another with T_h = 100-140ºC and 23-28 wt.% eq. NaCl. Evaporate mound analyses indicate these fluids have a complex chemistry with variable amounts of Na-Ca-K (avg. 70:20:10) with minor amounts of Fe-Mn-F; and (6) $\delta^{18}O$ values for whole rock (6.2 to 9.0 ‰) and quartz (SIMS analysis; 6.9 to 15.9 ‰) reflect re-equilibration of the granophyre with different fluids, one magmatic/metamorphic and the second surficial, likely seawater in origin. The above data are interpreted to indicate that the granophyric unit of the SIC records a complex and protracted history of fluid:rock interaction commencing with orthomagmatic fluids, ingress of externally derived metamorphic fluids and finally, the incursion of low-temperature saline fluids as the hydrothermal cell collapsed.