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Noble gases from fluid inclusions in the Hiltaba Suite granite, South Australia

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The Hiltaba Suite granite is a one of the largest felsic-dominated igneous bodies in the world. It intruded the Northern Gawler craton in South Australia during the Mesoproterozoic (~1.575-1.6 Ga). We investigated core samples from a geothermal exploration well drilled close to the Olympic Dam iron oxide-copper-gold (IOCG) ore deposits. The cores intersected the Hiltaba Suite granite at depths ranging between 718 m and 1935 m. The main aim was to study fluid inclusion occurrence in the granite and quantify noble gas isotopes and their isotope ratios. Such information, supplemented with auxiliary petrographic data, will be used to infer residence time and provenance of fluids. More specifically, identification of fluid origin in the granite requires distinguishing deep crustal fluids in primary and secondary fluid inclusions from recent atmospheric signals using noble gas elemental and isotopic signatures.

The Environmental Tracer Laboratory (ETL) of CSIRO, South Australia, has developed a new high vacuum crushing system to extract inclusion fluids from minerals and measure their noble gas concentrations and isotopic composition. The preparation system allows purifying the noble gas fractions and measuring in fully automated mode rare isotope ratios like $^{136}Xe/^{132}Xe$, $^{21}Ne/^{20}Ne$ and $^{3}He/^{4}He$ in groundwater and pore fluids. In fluid inclusions, these noble gas isotopes are the only means to evaluate how long fluids were isolated from the water cycle and to quantify primordial and radiogenic components.

Petrographic data identified alteration of minerals indicative of tectonic stress and hydrothermal water circulation mostly in the shallower and in the deeper part of the granite core. Fluid inclusion analysis showed no indication of circulation of recent meteoric water through the fracture network. Most of the fluid inclusions contain two phases (water and gas) in the grains as well as in the healed fractures. Salinity and temperature differences in the water-rich quartz inclusions indicate different fluids have circulated through the granite over time and were probably trapped at different times. Neon isotopes ($^{20}Ne/^{22}Ne$, $^{21}Ne/^{22}Ne$) measured on whole granite grains (1-2 mm) showed an increasing radiogenic contribution with depth indicative of very old fluid components that display long-term isolation from the surficial water cycle.