Constrains on the origin of fluid trapped in hydrothermal quartz from 2.4 Ga Ongeluk Fm., South Africa

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Fluid inclusions in hydrothermal quartz formed by seafloor hydrothermal alteration are considered as useful samples to reveal compositions of ancient seawater and atmosphere (e.g., [1]). The fluid inclusions in the 2.4 Ga Ongeluk Formation, South Africa, are expected to still retain seawater during the Paleoproterozoic Snowball Earth Event [2]. However, origin of the trapped fluids is still controversial due to insufficient geochemical constraints. Thus, to constrain the origin of fluids, we carried out Ar isotope analysis of the fluid inclusions in quartz samples via a stepwise crushing method after neutron irradiation [3].

Argon isotopes of the fluid inclusions in the quartz samples suggest that the fluid inclusions comprise three endmembers: 1) ^{40}Ar- and $^{39}Ar_K$-rich type (neutron-induced ^{39}Ar from K), 2) ^{40}Ar- and $^{38}Ar_{Cl}$-rich type (neutron-induced ^{38}Ar from Cl) and 3) atmospheric-Ar-rich type, on 3D $^{40}Ar/^{36}Ar$-$^{39}Ar_K$ /^{36}Ar-$^{38}Ar_{Cl}/^{36}Ar$ space. The highest $^{40}Ar/^{36}Ar$ value of 4153 (4086 at 2.4 Ga) in the fluid inclusions is consistent with an expected value of the Ongeluk plume source ($^{40}Ar/^{36}Ar$ = *ca.* 4000) [4]. The obtained ^{40}Ar contents is well correlated with the $^{38}Ar_{Cl}$ contents, suggesting that the ^{40}Ar is derived from excess ^{40}Ar ($^{40}Ar_E$) [5]. The lowest $^{40}Ar/^{36}Ar$ value at 0 of $^{38}Ar_{Cl}/^{36}Ar$ value (i.e., $^{40}Ar/^{36}Ar$ value subtracted by radiogenic ^{40}Ar and $^{40}Ar_E$) on $^{40}Ar/^{36}Ar$ vs. $^{38}Ar_{Cl}/^{36}Ar$ diagram is 307 ± 16 (2σ), which is similar to modern atmospheric $^{40}Ar/^{36}Ar$ value of 296. Those results support that the fluid inclusions were trapped from the seawater during the Ongeluk volcanism; thus retain the information of the ancient Ongeluk seawater.

[1] Nishizawa et al. (2007) *EPSL.* [2] Saito et al. (2016) *Precam. Res.* [3] Qiu and Wijbrans. (2008) *EPSL.* [4] Davies, GF. (2010) *G-Cubed*. [5] Kelley et al. (1986) *EPSL.*