P-T-t evolution of metapelitic rocks from the Bushveld contact aureole: Using garnet isopleths thermobarometry and Lu-Hf garnet dating

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We employ garnet isopleth thermobarometry and Lu-Hf garnet isotopic system in order to investigate the P-T-t evolution of two garnet bearing metapelitic samples (DY954 and DY918) from the Bushveld contact aureole. Two types of garnets porphyroblast were identified in sample DY954, garnet included in biotite which records peak metamorphic condition of 551 ±15^{0}C at 3.1±0.2kb and a non reactive garnet which records 527±8^{0}C at 3±0.35kb. The slightly higher temperature of the former may be interpreted to have resulted from garnet reaction overstepping. The DY918 amalgamated garnet porphyroblast does records different P-T conditions (~601^{0}C at 1.3kb) as compared to the DY954 sample and the fusion of the garnets which will require significant re-crystallization [1] can be attributed to these higher temperatures. The weighted average Lu-Hf garnets isochron ages obtain for the two samples (DY954 and DY918) are 2061.5±5.1Ma and, 2061.4±3.5Ma respectively. The nearly identical garnet isochron ages marks the first robust age of the BIC contact aureole which can be indirectly interpreted as constraints to the emplacement age of the RLS.

[1]Taylor, J. & Stevens, G. (2010) *Lithos* **120**, 277–292.

Heavy metal fractionation in high temperature fumaroles

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Some volcanoes discharge high temperature gases from which unique metal suites are formed as sublimates. Examples include Vulcano, Italy, where sublimates contain a wide range of rare bismuth-lead sulfosalt minerals. Paradoxically, arsenic minerals do not occur in fumarole discharges but are common in crater lakes. In paleo-fumarole environments such as Chinkuashih, Taiwan, enargite and related sulfosalts occur as almost mono-mineralic assemblages over a depth range of more than 1000 meters. Modelling of vapor-phase stabilities shows that decompressing volcanic gases deposit pyrite below 700ºC followed by rapid precipitation of enargite as depressurization proceeds. In consequence, surface discharges are strongly depleted in arsenic, iron, copper and a range of heavy metals.

Based on high resolution microanalysis of As-rich sulfosalt assemblages in paleo-fumaroles, we suggest that fractionation occurs between arsenic-rich sulfosalt melt and vapor within the upper few hundred meters of the surface, leading to heavy metal (Sb, Bi, Te, etc) enrichment of the vapor phase and consequent formation of lead-bismuth sulfosalt minerals and tellurides in surface discharges, such as the metallic snow of the Venus Highlands region. Similar sub-surface fractionation processes result in molybdenum-rhenium enrichment in volcanic systems such as Kudryavy (Kurile Arc, Russia), and gold and silver in others (e.g.Kudryavy and Colima, Mexico). Similar sulfosalt –sulfide melt segregation occurs in the magmatic environment resulting in metal fractionation during the formation of the so-called 'high sulfidation' and porphyry copper-gold deposits.