Decoupling of δLu/Hf and $^{230}Th/^{238}U$ in the Galapagos lavas: Who is who in the garnet signature

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High δLu/Hf and ($^{230}Th/^{238}U$) disequilibrium have been used as indicator of mantle melting in the garnet stability field. In contrast to our expectations, the Galapagos samples with high ^{230}Th excess have low δLu/Hf. 30 samples previously analyzed for Th isotopes (ranging from 0.98 to 1.484) have been analyzed for Hf isotopes (εHf ranging from 8.49 to 13.16; δLu/Hf 0.75 to 0.2). εHf and ^{230}Th excess increase, while δLu/Hf and $(Sm/Yb)_{PM}$ ratios decrease with increasing distance from the center of the plume (considered to be Fernandina based on $^{3}He/^{4}He$ isotopes). The increase in εHf and decrease in δLu/Hf and $(Sm/Yb)_{PM}$ ratios has previously been explained by a decrease in the depth of mantle melting, from the garnet to the spinel stability field, associated with an increase in the asthenospheric component in the source of melts erupted at increasing distance from the center of the plume. However, this hypothesis cannot explain the increase in ^{230}Th excess. Evaluation of trace element composition and Sr, Nd, Pb, Hf, He and Th isotopes of Galapagos lavas indicates that magma mixing between plume and asthenosphere melts has been the main process responsible for the geochemical variation observed in the archipelago. The correlation between isotopes and trace element ratios (such as Nb/La, Nb/Zr, Ba/La, K/Rb and Ba/Ce) indicates that magma mixing controls most of the trace element variations in the basalts. The correlations between ($^{230}Th/^{232}Th$) and Sr, Nd, Hf and Pb isotopes confirm that the Th isotopic ratios are mainly source-controlled and are the result of magma mixing between the plume and asthenosphere melts. The high ($^{230}Th/^{238}U$) disequilibrium found in Galapagos lavas indicates that they originated total or partially in the garnet stability field. The decoupling between the ($^{230}Th/^{238}U$) excess and δLu/Hf can be accounted for by mixing of low extent of melting from a plume source in the garnet stability field with magmas produced by relatively large extents of melting from the asthenosphere in the spinel stability field. This mixing model illustrates that the mixture carries a garnet signature in the most incompatible elements (such as U, Th) even though the variation of the MREE (and Hf) to HREE does not reveal any indication of melting in the garnet stability field.

Genesis and timing of mineralization in the Wynad gold field, Southern India

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The genetic modeling of gold deposits has been a topic of frontline research in the past few decades and is inexorably linked with the source of the auriferous fluid and its components. The source of these fluids have been one of the most contentious problems and has been variously ascribed to magmatic, exhalative, metamorphic outgassing, meteroic water circulation or a combination of all of the above, based on stable isotope tracers (Hagemann and Cassidy, 2000 and references therein). Mantle degassing-granulitization has also been invoked in several studies and the possible orthomagmatic link to felsic rocks has been revived.

In southern India, primary gold occurrence is mainly restricted to four main gold fields- The Kolar, Hutti, Ramagiri and the Wynad. The Kolar, Hutti and Ramagiri occur within a granite-greenstone terrain, while the Wynad within a granulite grade metamorphic terrain. Primary gold in Wynad is mainly associated with the quartz-sulfide vein system and less commonly in the altered host rocks. Here we present a model for the Wynad gold mineralization, integrating carbon isotope analysis of fluid inclusions combining them with sulfur and radiogenic isotope studies of sulfides and hydrothermal alteration.

Stable carbon isotopic composition of fluid inclusions from gold-quartz veins in the Wynad gold field range from ca. –3.0‰ to –4.8‰ (PDB), indicating a homogeneous and magmatic source for the fluids, while the co-existing ankerite, show lighter isotopes ranging from -6‰ to -7‰ (PDB). Sulfur isotopes of pyrites from the quartz veins and hydrothermally altered host rocks show $\delta^{34}S$ between + 2.4 and +5.2 ‰ (CDT), which substantiates our evidence for a magmatic origin.

The K-Ar ages obtained from hydrothermally altered mica indicate an age of ca. 509±9 Ma for the mineralization. A genetic model involving a direct link to mantle source is envisaged, which post dated the regional retrograde metamorphism. Gold deposition might have occurred by cooling and H_2S loss due to fluid-wall rock interaction.

Reference

Hagemann S.G., Cassidy K.F., (2000). Archean orogenic lode gold deposits In: Hagemann S.G., Brown P.E., (eds.) Gold in 2000 *SEG reviews* **13**, 9-68.