(U-Th)/He dating of native gold: Problems and perspectives

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As it has been suggested long time ago helium can easily escapes from crystal structures of minerals. However nowadays earlier preconceived ideas about the quick migration of helium from all materials should be revised.

There is a group of minerals, namely native metals, where the retention of radiogenic helium is rather high. Helium due to its very low solubility in metals tends to form atomic clusters. Migration of such stable clusters needs relatively high temperatures that are close to the metal melting point [1]. Anomalously high retention of radiogenic helium in native metals is experimentally shown on the example of native minerals of platinum. Finding paves the way for creation a novel ^{190}Pt-^{4}He method of isotope geochronology [2].

Aforementioned indicates that theoretically retention of radiogenic helium in native gold also should be high. Taking into account that the concentration of U in native gold varies from first ppb to hundreds of ppm, there are rather high possibility for the direct dating of native gold by the (U-Th)/He method. Importance of this opportunity needs no explanations.

By the way first attempts of the direct (U-Th)/He dating of native gold seems to be inaccurate. Method easily could distinguish events within hundreds of million years. Nevertheless there was large dispersion in obtained ages. And as it become clear nowadays one of the main reasons of this dispersion hides in the problem of the behavior of uranium in native gold. After extended detailed SEM study of native gold it was shown that U and Th mainly occurs in gold as submicron inclusions of phosphates of REE that are very sensitive to secondary processes. In this way reliable age determination of native gold requires careful mineralogical study and appropriate sample preparation as well as special methodological approach for release of radiogenic He from native gold.

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Phase equilibria modelling of open system melting: Some implications

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Decompression melting has been invoked as an important process in tectonics. To evaluate this postulate, the melt production from metapelite and greywacke during high-*T* decompression is evaluated using *P*–*T* pseudosections calculated in the Na_2O–CaO–K_2O–FeO–MgO–Al_2O3–SiO_2–H_2O–TiO_2–Fe_2O_3 chemical system. Both closed system (undrained) and open system (drained by episodic melt loss) conditions are investigated. In nature, closed system behaviour is unlikely to be important in crustal differentiation. For drained conditions, at each point along the *P*–*T* path where the melt fraction reaches 7 mol%, 6/7ths of the melt produced is removed from the bulk chemical composition and a new phase diagram is calculated for the residual composition. First, we consider melt production along schematic *P*–*T* paths comprising an isobaric heating segment at 1.2 GPa followed by decompression to 0.4 GPa at 750°C, 820°C, and 890°C. The maximum amount of melt produced during decompression occurs at the lowest temperature investigated (750°C). Along this *P*–*T* path, the melt volume does not reach 7 mol% prior to decompression; during decompression the metapelite generates 15 mol% and the greywacke 12 mol% melt. This amount is significantly less than commonly invoked in some discussions of orogenic collapse. Isobaric heating to 820°C and 890°C produces significantly more melt along the prograde segment, resulting in multiple melt drainage events prior to decompression, which leads to lower melt production during decompression. Second, we consider melt production from the solidus at 1.2 GPa to peak *P*–*T* of 860°C at 1.8 GPa followed by isothermal decompression to 0.4 GPa. For drained conditions along this schematic *P*–*T* path, the metapelite generates only 1/4 of the cumulative total of 31 mol% melt during decompression, whereas the greywacke generates 1/3 of the cumulative total of 19 mol% melt during decompression. The effects of melt loss on the dissolution of zircon and monazite are evaluated and the implications for the interpretation of U–Pb ages will be discussed. Some models for the structural and thermal development of migmatite domes and metamorphic core complexes may require reevaluation. In particular, the role of melt transfer through suprasolidus crust and melt accumulation at shallow levels in the anatectic zone should be considered rather than simply invoking the presence of large volumes of melt in decompressing crust.

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