Helium isotopic composition of fluid inclusions hosted in massive sulfides from modern hydrothermal systems

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Helium isotopic compositions of fluid inclusions trapped in sphalerite and chalcopyrite from modern hydrothermal systems were measured by crush-extraction technique. The samples originate from a stockwork mineralization in the upflow zones of hydrothermal fluids in the JADE field and from mounds on the seafloor in the North Fiji Basin.

The JADE field is situated in a marginal intra-continental back-arc basin in the Central Okinawa Trough (Japan) and hosted by intermediate to felsic volcanic rocks. The site is composed of active and inactive chimneys as well as mounds on the seafloor at a water depth between 1300 and 1550 m. Fluid inclusions in sphalerite samples from a stockwork mineralization show $^3He/^4He$ ratios in a narrow range of 5.42 ± 0.30 R_A, similar to values between 5.89 and 6.50 R_A reported for vent fluids from the JADE field (Ishibashi et al., 1995). These results indicate that helium isotopes in fluid inclusions trapped in hydrothermal sulfides are representative of those of the vent fluids from which they were deposited.

The North Fiji Basin (SW-Pacific) is a mature intra-ocean back-arc basin. The studied samples originate from an active hydrothermal field located in a water depth of ~2000m. The hydrothermal fluids have precipitated massive sulfides (sphalerite, pyrite, marcasite) in mounds on the seafloor; however, the hydrothermal intensity has decreased from that associated with “black smokers” to “white smokers”. At the Fiji site the $^3He/^4He$ ratios of basalt glasses vary between 7.91 and 9.80 R_A (Nishio et al., 1998). The lowest values were reported for N-MORB basalts whereas glasses from OIB-type alkali basalts yielded higher $^3He/^4He$ ratios. Our data for fluid inclusions in chalcopyrite show $^3He/^4He$ ratios between 8.5 and 10.6 R_A. The lowest values are observed in chalcopyrites which are assumed to have deposited from black smoker fluids, whereas those probably deposited from white smoker fluids show higher $^3He/^4He$ ratios similar to those of sphalerite-hosted fluid inclusions from replacement ores (9.2 to 10.2 R_A). These findings support previous conclusions that the white smoker activity is related to the younger intrusion of alkalic OIBs in the study area whereas the black smoker massive sulfide mineralization is related to the older N-MORB system (Halbach et al., 1999).

Halbach P., Rahders E., Halbach M. and Seifert T. (1999) *in:* Mineral Deposits: Processes to Processing, 511-514.

Ishibashi J. et al. (1995) *Chem. Geol.* **123**, 1-15.

Nishio Y. et al. (1998) *Earth Planet. Sci. Lett.* **154**, 127-138.

Extracting reliable U-Pb ages and errors from complex populations of zircons from Phanerozoic tuffs

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Zircon U-Pb ages of Phanerozoic tuffs are invaluable for studies requiring time-scale geochronology; however, modern studies show that zircon populations from such rocks are often vulnerable to both positive (from xenocrysts or cores) and negative (from Pb loss) age biases. Though biases from significantly older zircon cores and large degrees of Pb loss are easily avoided, problems arising from slightly older xenocrysts and from subtle degrees of Pb loss can be difficult to resolve, and often force the analyst into uncomfortably subjective decisions. In particular, strong trimming of data sets to obtain clusters with MSWD values close to 1 is likely to yield a biased age, with assigned errors that are erroneously small. To improve this unsatisfactory situation, we have developed *TuffZirc*, a robust algorithm that is largely insensitive to both Pb loss and inheritance, without entirely ignoring the valuable information provided by analytical errors. The data required by *TuffZirc* reflect the philosophy that, for time-scale geochronology using zircons, anything less than rather large data-sets (say N>12) of concordant $^{206}Pb/^{238}U$ ages on single-crystal or smaller samples is inadequate for the task.

The *TuffZirc* algorithm proceeds as follows: 1) the 12-20 analyses (if via ID-TIMS, on single crystals that were abraded and/or strongly leached with HF or NaOH – whichever approach best minimizes age-lowering by Pb loss) are precleaned of analyses with anomalously high errors, then ranked according to $^{206}Pb/^{238}U$ age; 2) the largest cluster of the ranked analyses is found that yields a "probability-of-fit" (in the conventional geochronological sense) of >0.05; 3) the median age of the largest cluster, without regard to analytical errors, is taken as the true age, with the (asymmetric) 95%-conf. errors of the median age as its uncertainty. Monte Carlo testing indicates that, as long as a reasonable fraction (say >40%) of the analyzed crystals are both cogenetic with the main eruption that produced the tuff and also free of Pb loss, both the *TuffZirc* age and its error are reliable – even in the presence of xenocrysts only few Myr older than the syn-eruptive tuff zircons, when the xenocrysts themselves have suffered Pb loss, and for a variety of distributions and magnitudes of Pb loss.