Helium characteristics in granites from North Qinling Orogen, China: Implications for granite as an effective helium source rock

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Helium is a strategic resource that has been widely used in cryogenic superconductor and scientific research. However, the liquid helium crisis in recent years has attracted broad attention to the ^{4}He reserves around the world[1-2]. There are widespread crustal-derived He in geothermal wells from Weihe Basin, central China, with the average He content being 1% and the peak value reaching up to 9.23%. It is suggested that the accumulation of He is closely related to granitoid basement or intrusion by studying the geological settings of some He-rich gas fields. In this project two granitic rock samples collected from North Qinling Orogen, Central China, in the south of Weihe Basin, are analyzed for U, Th concentrations, EMPA images, He concentrations and isotopic ratios by crushing and stepwise heating.

U and Th concentrations in the granites are 1.5-3.4 times of the Clark values and they tend to be in independent minerals, or isomorphously, in accessory minerals. He contents in granite extracted by crushing are 0.95 and 0.13 ucm^3 STP/g, with corresponding ^{3}He/^{4}He ratios being 0.016Ra and 0.056Ra (where Ra is the atmospheric ratio of ^{3}He/^{4}He = 1.4×10^{-6}), which exhibit the features of crust-derived source. He extracted by step-wise heating are 114.74 and 7.76 ucm^3 STP g^{-1} with average ^{3}He/^{4}He ratios being 0.033 and 0.030Ra. Therefore, the amounts of He released by step-wise heating are 882.62 and 8.17 times of those extracted by crushing. Dividing the measured He concentrations by the calculated theoretical He abundances based on U and Th radioactive decay, it turned out that less than 10% of radiogenic He since the formation of the granites can be preserved over geological time, i.e., more than 90% of produced He migrate to elsewhere. He diffusion features will be discussed based on step-wise heating. Given the high generation rate (abundant U and Th content) and high He releasing rate (>90%), granite could be an important helium source rock.

[1] S.R. Bare et al.(2016), Washington DC: APS.
[2] C.J. Ballentine et al.(2017), Goldschmidt Abstract.