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Correlated Argon and Oxygen Isotopes in UHP Eclogites from Qinglongshan (Sulu Terrain, China): Evidence for Inherited Argon

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The UHP eclogitic rocks from Qinglongshan (Sulu terrain, eastern China) have been intensively studied because of their distinctive UHP parageneses, "excess" argon, and uncommon oxygen isotopic signatures. Unusually low $\delta^{18}O$ values ($-15^0/_{00}$ to $-1^0/_{00}0$) for the UHP minerals have been reported and interpreted as the result of meteoric water-rock interaction prior to Triassic (220-240 Ma) continental collision and UHP metamorphism. These results indicate that the oxygen isotopic system remained closed during subduction. In addition, eclogitic phengites have been reported to contain up to 70% of extraneous argon (not produced by *in-situ* radioactive decay), which has been interpreted as excess argon. In order to understand better the origin and nature of the extraneous argon, *in-situ* $^{40}Ar/^{39}Ar$ ultraviolet (UV)-laser probe and conventional furnace step heating analyses, together with stable oxygen analyses of phengites from Qinglongshan were made. *In-situ* UV laser $^{40}Ar/^{39}Ar$ results from eclogite samples indicate that the argon is entirely restricted to early-formed phengite and epidote and later-formed barroisite; these are the only minerals with the potential crystallographic affinity to accept argon in their structures. Moreover an intragranular correlation between apparent age and chemical composition in phengite is consistent with some argon loss during exhumation. On the basis of these in-situ results, an early (possibly during phengite crystallization) introduction of extraneous argon is suggested. Conventional furnace step heating of phengite from different eclogitic lithologies (quartzite, eclogite, gneiss) yield variable $^{40}Ar/^{39}Ar$ total gas ages (no plateau ages) between 280 Ma and 950 Ma, indicating a variable extraneous argon content between the samples. Two biotites and three feldspars from gneisses yielded total gas ages between 200-202 Ma and 190-198 Ma respectively. So far the extraneous argon seems to be located in minerals which have the greatest argon retentivity. Furthermore we found a surprising correlation between $\delta^{18}O$ values and $^{40}Ar/^{39}Ar$ total gas ages for the different phengite samples. The lowest $\delta^{18}O$ values in phengite have the oldest apparent ages and the highest $\delta^{18}O$ values have the youngest apparent ages (see Figure 1). The origin of this correlation between stable and radiogenic isotopes is still unknown, but the variation in the $\delta^{18}O$ values (-9.7 to -1.2) amongst the phengite samples has been interpreted to reflect premetamorphic heterogeneity between the different protoliths for these samples. Moreover there is no reason to suggest that such a systematic correlation between argon and oxygen isotopes was produced during exhumation. Consequently this correlation and the total gas age heterogeneity between the different samples of phengites seems best explained as a premetamorphic variation in protolith isotopic signature, suggesting that the extraneous argon signature is inherited and not "excess". These results indicate that inherited argon surviving UHP metamorphism is highly probable in the Qinglongshan rocks. The lack of fluid circulation in the UHP rocks, consistent with the stable isotope data, may be the key for such a signature. Evidence of argon loss during exhumation and the presence of veins crosscutting the main lithologies means that late fluid circulation could have also played a role in the introduction of true excess argon. For example, samples from nearby localities having extraneous argon (total gas ages of 300 Ma and 470 Ma and $\delta^{18}O$ values of 7.9 and 5.3 respectively) could have been contaminated by such late fluid circulation thus yielding apparent ages older than their Triassic metamorphic ages. Therefore, inherited argon maybe restricted to a relatively local area.

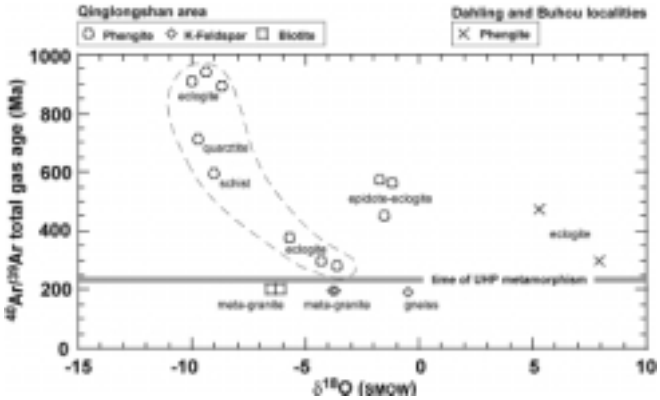

Figure 1. Plot of $\delta^{18}O$ versus $^{40}Ar/^{39}Ar$ total gas age for K-bearing minerals from Qinglongshan UHP area