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Noble gases (He, Ne and Ar) in seafloor and high pressure metamorphic deep-sea sediments

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It was suggested that solar type He and Ne in Earth´s mantle are due to subduction of extraterrestrial dust [1]. We measured He, Ne and Ar extracted by stepwise heating from magnetic separates of two pelagic seafloor sediments of a drillcore (LR44-GPC-3) in the pacific ocean and three metasediments (different layers) from Andros (Greece) and Laytonville (California/USA) both formed at c. 8kbar and 400°C suggesting a maximum subduction depth of c. 20km.

The two seafloor sediment samples contain solar wind implanted He and Ne. The $^{3}He/^{4}He$ ratios vary between 1.71 ± 0.05 (1σ) and 2.47 ± 0.04 $\cdot 10^{-4}$ indicating SEP He. $^{20}Ne/^{22}Ne$ (between 10.75 ± 0.31 to 11.21 ± 0.35) and $^{21}Ne/^{22}Ne$ ratios also agree with SEP composition. The $^{40}Ar/^{36}Ar$ ratios range from 297 ± 7 to 578 ± 16 (due to ^{40}Ar from ^{40}K-decay) with $^{38}Ar/^{36}Ar$ ratios from 0.184 ± 0.002 to 0.194 ± 0.008, indistinguishable from air composition. No ^{3}He was detected in the five metasediment samples, while the ^{4}He amount was very high suggesting radiogenic He (e.g. from alpha decay). The Ne isotope ratios were affected by nucleogenic production of ^{21}Ne (from ^{18}O) and ^{22}Ne (from ^{19}F). The $^{20}Ne/^{22}Ne$ ratios are c. 9.80 (air ratio), $^{21}Ne/^{22}Ne$ ratios are between atmospheric composition and 0.1003 ± 0.0013. $^{40}Ar/^{36}Ar$ ratios are always above atmospheric composition with a maximum of 19755 ± 51, with $^{38}Ar/^{36}Ar$ ratios within the range of air.

While solar He and Ne are present in the seafloor sediments, these components could not be detected in the metasediments. Their He, Ne and Ar compositions were overprinted by radioactive decay (He from U or Th; ^{40}Ar from ^{40}K) and nucleogenic reactions. These results do not support significant subduction of IDP-derived solar type noble gases into the Earth's mantle.

Reference

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Re-Os systematics of the UHP Dabie-Sulu terrain, China: Results from Qinglongshan

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The Dabie-Sulu terrain, located in eastern central China, is the largest ultrahigh pressure orogenic belt in the world. This UHP belt was formed by crustal subduction and subsequent exhumation during the collision of the Yangtze and Sino-Korean plates at about 220 to 240 Ma. One particularly interesting feature of the Dabie-Sulu orogen is the remarkably ^{18}O-poor signature of many of the subducted rocks, which has been interpreted to result from the circulation of meteoric water prior to the time of subduction [1, 2]. This low $\delta^{18}O$ signature is particularly well-developed in the Qinglongshan locality of the Sulu region.

We report here preliminary results from a Re-Os isotopic study of the Qinglongshan eclogites. Whole rock samples, separated by several meters in outcrop, yield a Re-Os isochron with an age of about 228 Ma, consistent with the accepted age of subduction. This implies that Os isotopic equilibration occurred over distances of several meters during subduction. Interestingly, the initial $^{187}Os/^{188}Os$ ratio of the isochron (~ 0.3) is relatively unradiogenic. This is surprising given that the basaltic protoliths of these rocks are at least 700 Ma old. Basalts with typical Re/Os ratios would develop much higher $^{187}Os/^{188}Os$ ratios in 700 Ma. However, the Re concentrations of these rocks (5 to 56 ppt) are much lower than those of most basalts. Thus the simplest explanation of the low initial Os ratio is that Re loss occurred soon after formation of the basaltic protolith, limiting the extent of radiogenic ingrowth of ^{187}Os. Assuming that this Re loss was provoked by the episode of pervasive, cold meteoric water circulation suggested by the oxygen data, the Re-Os results indicate that this event predated subduction by several hundred Ma. Thus the Re-Os data are consistent with the suggestion (e.g. [2]) that meteoric water circulation at Qinglongshan occurred during a Neoproterozoic "snowball Earth" glaciation.

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