

カメルーン火山列上のSao Tome島、Bioko島のガス中の希ガス

He, Ne and Ar in Spring Gases from the Cameroon Volcanic Line Islands of Sao Tome and Bioko, West Africa

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カメルーン火山列 (CVL) は大西洋からアフリカ大陸カメルーンを縦断する火山の連なりである。我々はこのCVL マグマをもたらす大陸及び大洋下部リソスフェア・マンツルの希ガスを研究している。ここでは、CVL に属する二つの島Sao TomeとBiokoで採取した炭酸ガスに富むガス試料のHe, Ne, Arについて述べる。3He/4He 比は大気Heの値 ($R_a=1.4E-6$) の 2.8 ± 0.4 から 7.1 ± 0.1 倍であった。Sao Tomeの、この高い方の値は南大西洋火山の値と類似していて、もとはMORB起源と思われる。Biokoの低い $4.7 \pm 0.1R_a$ は高い $(U+Th)/3He$ と時間的な積分効果によるものとすれば、この島がHIMU火山島であるという説に別の新たな証拠を提供したことになる。

The Cameroon Volcanic Line (CVL) is a linear chain of Tertiary to Recent, essentially alkaline intraplate volcanoes that trends in an ENE-WSW direction for 1600 km from the Atlantic ocean straddling the continental margin into mainland Africa. We are carrying out a project to study the elemental and isotopic compositions of all noble gases (helium to xenon) in mantle-derived materials along the CVL. The project aims at quantifying and comparing the noble gas systematics of the suboceanic and subcontinental lithospheric mantle domains involved in generating CVL magmatism. Sample types under investigation are collected from 10 of the 12 volcanic centers that constitute the entire CVL, and include CO₂-rich spring gases, whole rock ultramafic xenoliths and their mineral separates, clinopyroxene megacrysts, and basaltic to basanitic lava-hosted olivine/pyroxene phenocrysts. The results of the study have implications not only on the debated origin of the volcanic chain, but also on the influence that the subcontinental (1-2 Ga) and suboceanic (<100 Ma) lithospheres have in modifying noble gas compositions in the mantle. This abstract reports He, Ne and Ar results of CO₂-rich spring gases in Sao Tome (4 springs) and Bioko (1 spring). Sao Tome and Bioko are 2 of the 4 islands of oceanic CVL. 3He/4He ratios range from 2.8 ± 0.4 - 7.1 ± 0.1 times the air value (R_a) of 1.4×10^{-6} (Bioko spring = $4.7 \pm 0.1R_a$). 4He/20Ne ratios are up to 790 times higher than the air ratio of 0.32. Assuming the 3He/4He and the 4He/20Ne ratios of atmospheric, crustal and upper mantle sources to be ($1.4 E-6$, 0.32); ($2.8E-7$, $1E8$) and ($1.1E-5$, $1E4$) respectively, the estimated relative contributions of atmospheric, crustal and mantle sources to total measured He indicate that the Sao Tome samples contain 90% He of mantle origin, while the rest can be accounted for by crustal (10%) and atmospheric (<1%) contamination. The highest observed 3He/4He ratio for Sao Tome ($7.1 \pm 0.1R_a$) is similar to the south Atlantic value of $7.86R_a$. We interpret this to mean that the He in the Sao Tome springs was originally derived from a source similar to MORB but has suffered some crustal and atmospheric contamination. The nature of the crustal contamination (e.g. shallow level magma storage in crustal chambers) is the subject of further investigation. The 3He/4He ratio of the Bioko gas ($4.7 \pm 0.1R_a$) is 40% more radiogenic than in MORB. The mixing model above suggests that such a ratio can be accounted for by mixing in the proportions 0.6, 0.4 and <0.1 respectively between mantle, crustal and atmospheric He. However,

considering (1) that this value is within the range of literature values for $3\text{He}/4\text{He}$ ratios (4 - 6Ra) in lavas of south Atlantic ocean island hotspots like St Helena, Gough and Tristan da Cunha and (2) that Bioko has been considered to be a HIMU oceanic island on the basis of Pb isotope studies, one possible explanation for the observed ratio is that it results from increased time integrated $(\text{U}+\text{Th})/3\text{He}$ ratio in the source region. If correct, then this result is additional evidence that Bioko may be a HIMU oceanic island and thus different from Sao Tome. This hypothesis shall be tested by measurement of $3\text{He}/4\text{He}$ ratios in fluid inclusion-trapped (crushed phenocrysts) He of lavas from both islands. $^{20}\text{Ne}/^{22}\text{Ne}$ ratios in the spring gases are atmospheric within analytical uncertainties. $^{21}\text{Ne}/^{22}\text{Ne}$ and $^{40}\text{Ar}/^{36}\text{Ar}$ are 3-17% and 10-20% respectively, enriched (with respect to atmospheric ratios) in nucleogenic (^{21}Ne) and radiogenic (^{40}Ar) components. Radiogenic $^4\text{He}/^{40}\text{Ar}$ ratios range from 1.32 - 4.17, which is within a factor of 1 - 3.5 of ratios predicted from the radioactive decay of U, Th and K in the associated rocks with Th/U ratios of 3 - 4.5 and K concentrations of 2.0 to 3.4 wt.%. No isotopic anomalies were observed in Kr and Xe of the spring gases.