

The first stepwise crushing data on C, N and Ar isotopic and elemental ratios in Guli carbonatites

A.I. BUIKIN¹, A.B. VERCHOVSKY², V.A. GRINENKO¹ AND L.N. KOGARKO¹

¹Vernadsky Institute of Russian Academy of Sciences, Moscow, Russia (bouikine@mail.ru)

²The Open University, Milton Keynes, UK

To get insight into the fluid regime evolution during formation of Guli massif (Maymecha-Kotuy magmatic complex, Syberia) carbonatites we have studied C, N and Ar isotopic and elemental ratios in four carbonatite samples by stepwise crushing method. Mineral separates representing different formation stages of the massif have been selected for the investigation: two early calcites (Cal) and a late stage dolomite (Dol) and siderite (Sid).

The early calcites are characterized by significantly lower CO₂ content and lower $\delta^{13}\text{C}$ values than the late Dol and Sid (-14.1, -13.6‰ and -9.0, -10.5‰ in average respectively). Fractionation during melt degassing (when system is closing) could lead to a higher CO₂ content with higher $\delta^{13}\text{C}$ values in the late minerals. But the results on C, N and Ar elemental compositions in the fluid inclusions have shown that C/N and C/Ar ratios also dramatically increase from the early to the late samples (C/N: from 7 in Cal to 210 in Sid and 2100 in Dol; C/Ar: from 870 in Cal to 12300 in Sid and 159000 in Dol), which could not be caused by a simple magmatic fractionation. An additional source of CO₂ could appear at the late stages of the fluid-magmatic evolution of the massif. The data on C, N and Ar concentration variations in crushing steps support this assumption: well-defined correlations between concentrations of these elements in fluid inclusions are observed in the early Cal (i.e. all gases in the inclusions have the same elemental composition and consequently the same source). For the late Sid and Dol the situation is different: when N and Ar concentrations decrease with crushing steps, the C concentration is increasing, suggesting different sources for (N+Ar) and for most of CO₂. Moreover, ⁴⁰Ar/³⁶Ar ratios in early and late samples are quite different: 3680 in Cal and 657 and 549 in Sid and Dol, respectively. This suggests the air-like argon component to be dominated in fluids during formation of the late minerals. Thus, relationships between C, N and Ar concentrations as well as differences in C and Ar isotopic compositions in fluid inclusions of the early and late carbonatites suggest that at the late stages of Guli massif carbonatites formation an additional CO₂ source with heavier carbon and atmosphere-like Ar have contributed to the system.

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The expansion of metal stable isotope biogeochemistry into biomedicine

T.D. BULLEN* AND M.-N. CROTEAU

US Geological Survey, Menlo Park, CA 94025, USA

(*correspondence: tdbullen@usgs.gov, mcroteau@usgs.gov)

Numerous metals are essential nutrients for human health, while others are toxic even at extremely low concentrations in body fluids and tissues. Moreover, a variety of metals and most recently nanometer-sized metals are increasingly being used as components of diagnostic and therapeutic agents to study or treat diseases and metabolic disorders as well as for drug and gene delivery, tissue engineering and pathogen detection. Several of the metals studied in the field of biomedicine, including Li, Ca, Fe, Cr, Zn, Cu, Mo, Ni, Cd and Hg, have variable stable isotope composition in natural materials which can now be measured accurately. Application of stable isotope tracing techniques normally used to study biogeochemical systems could be invaluable to biomedical research. Metal stable isotopes can be used to understand processes such as metal transfer among body pools, and may uniquely identify the fate of toxic metals delivered to the body in different forms such as nanoparticles or aerosols. Initial work has focused on Ca and Fe stable isotope variations in humans, reflecting the importance of bone mineral balance and blood chemistry to human health as well as the advanced state of analytical techniques for the determination of Ca and Fe stable isotope compositions.

Both natural abundance and enriched stable isotopes can be used to provide increased understanding of metabolic processes and pathways at a mechanistic level. Natural abundance stable isotope variations between ingested and excreted metals may prove useful for determining the onset of and recovery from metabolic disorder or disruption of homeostasis. Enriched stable isotopes may be particularly useful for studying processes involving metals in the body, since only very small quantities of enriched tracer are needed in the exposure media in order to create a signal in body tissues and fluids above background levels. Carefully crafted laboratory experiments with lower trophic level organisms will help guide the application of these tools to biomedicine. Coupled with continual advances in mass spectrometry, expansion of metal stable isotope biogeochemistry into the field of biomedicine will be an exceptional research opportunity for the coming years. Involving experts from the medical and other professions in this work and learning their "language" will be essential for success.