

Equipment and newly developed methodological approaches for isotopic-geochemical studying fluid phases in rocks and minerals

Buikin A., Nevinnyi Y., Kamaleeva A., Sevast'yanov V., Kuznetsova O.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2017, Pleiades Publishing, Ltd. The paper presents data on an original equipment complex, consisting of two apparatuses, designed to prepare rock and mineral samples for the isotopic analysis of their fluid and/or gas inclusions. An example of samples from the Guli alkaline ultramafic massif in the Maimecha-Kutui province, northern central Siberia, is employed to demonstrate the capabilities of the technique of stepwise sample crushing and multiple-isotope analysis of the fluid phase.

<http://dx.doi.org/10.1134/S0016702916130024>

Keywords

and oxygen isotopes, carbon, carbon dioxide, equilibrium complex for gas sample preparation, fluid inclusions, hydrogen, inlet unit, isotopic analysis, water

References

- [1] S. Basu and S. V. S. Murty, "Nitrogen and argon in Sung Valley and Ambadongar carbonatite complexes: Evidence of incomplete homogenization of mantle and recycled components," *J. Asian Earth Sci.* 107, 53–61 (2015).
- [2] Y. Bottinga, "Calculation of fractionation factors for carbon and oxygen exchange in the system calcite-carbon dioxide-water," *J. Phys. Chem.* 72, 800–808 (1968).
- [3] A. I. Buikin and Yu. A. Nevinny, "Sample Preparation Line for Gases from fluid inclusions in rocks and minerals," Patent no. RU 2449270 (2012).
- [4] A. I. Buikin, M. Trieloff, J. Hopp, T. Althaus, E. V. Korochantseva, W. H. Schwarz, and R. Altherr, "Noble gas isotopes suggest deep mantle plume source of late Cenozoic mafic alkaline volcanism in Europe," *Earth Planet. Sci. Lett.* 230, 143–162 (2005).
- [5] A. I. Buikin, A. B. Verchovsky, V. A. Grinenko, S. A. Silantyev, V. S. Sevastyanov, Yu. A. Nevinny, and E. P. Smirnova, "C, N, He, and Ar isotope and element ratios in fluid inclusions from MORB chilled glasses: stepwise crushing data," *Geochem. Int.* 51 (4), 338–344 (2013).
- [6] A. I. Buikin and Yu. A. Nevinny, "System for injection of gases and their mixtures in mass spectrometer," Patent for Useful Model No 147559 (2014).
- [7] A. I. Buikin, I. P. Solovova, A. B. Verchovsky, L. N. Kogarko, and A. A. Averin, "PVT parameters of fluid inclusions and the C, O, N, and Ar isotopic composition in a garnet lherzolite xenolith from the Oasis Jetty, East Antarctica," *Geochem. Int.* 52 (10), 805–821 (2014a).
- [8] A. I. Buikin, A. B. Verchovsky, N. V. Sorokhtina, and L. N. Kogarko, "Composition and sources of volatiles and noble gases in fluid inclusions in pyroxenites and carbonatites of the Seblyavr Massif, Kola Peninsula," *Petrology* 22 (5), 507–520 (2014b).

- [9] A. I. Buikin, J. Hopp, M. Trieloff, and L. N. Kogarko, "Stepwise crushing data on light noble gases in Guli massive peridotite and carbonatites," in Abstracts of the 25th V.M. Goldschmidt Conference, Prague, Czech Republic, 2015 (Prague, 2015), A. 418.
- [10] A. I. Buikin, O. V. Kuznetsova, V. S. Sevast'yanov and Yu. A. Nevinny, "A new injection technique of microquantity of water from fluid inclusions into mass spectrometer for measurement of hydrogen and oxygen isotope compositions," *Geochem. Int.* 54 (2), 205-207 (2016a).
- [11] A. I. Buikin, A. B. Verchovsky, L. N. Kogarko, V. A. Grinenko, and O. V. Kuznetsova, "The fluid phase evolution during the formation of carbonatite of the Guli Massif: evidence from the isotope (C, N, Ar) data," *Dokl. Earth Sci.* 66 (2), 135-137 (2016b).
- [12] P. N. Cartigny, F. Jendrejewski, Pineau, E. Petit, and M. Javoy "Volatile (C, N, Ar) variability in MORB and the respective roles of mantle source heterogeneity and degassing: the case of the South-West Indian Ridge," *Earth Planet. Sci. Lett.* 194, 241-257 (2001).
- [13] N. Dauphas and B. Marty, "Heavy nitrogen in carbonatites of the Kola Peninsula: a possible signature of the deep mantle," *Science* 286, 2488-2490 (1999).
- [14] A. Demeny and Z. Siklosy, "Combination of off-line preparation and continuous flow mass spectrometry: D/H analyses of inclusion waters," *Rapid Commun. Mass Spectrom.* 22, 1329-1334 (2008).
- [15] L. S. Egorov, Ijolite-Carbonatite Plutonism by the Example of the Maimecha-Kotui Complex of the Polar Siberia (Nedra, Leningrad, 1991) [in Russian].
- [16] J. Hopp, J. M. Trieloff, and R. Altherr, "Neon isotopes in mantle rocks from the Red Sea region reveal large-scale plume-lithosphere interaction," *Earth Planet. Sci. Lett.* 219, 61-76 (2004).
- [17] B. Marty and L. Zimmermann, "Volatiles (H, C, N, Ar) in Mid-Ocean ridge basalts: assessment of shallow-level fractionation and characterization of source composition," *Geochim.Cosmochim. Acta* 63, 3619-3633 (1999).
- [18] B. G. Pokrovsky, Crustal Contamination of Mantle Magmas: Evidence from Isotope Geochemistry, (Nauka, Moscow, 2000) [in Russian].
- [19] Ph. Sarda, Th. Staudaher, and C. J. Allegre "Ar/Ar in MORB glasses: constraints on atmosphere and mantle evolution," *Earth Planet. Sci. Lett.* 72, 357-375 (1985).
- [20] P. Scarsi, "Fractional extraction of helium by crushing of olivine and clinopyroxene phenocrysts: Effects on the He/He measured ratio," *Geochim. Cosmochim. Acta* 64 (21), 3751-3762 (2000).
- [21] T. P. Staudaher, S. H. Sarda, Richardson, C. J. Allégre, I. Sagna, and L.V. Dmitriev, "Noble gases in basalt glasses from a Mid-Atlantic Ridge topographic high at 14 N: Geodynamic consequences," *Earth Planet. Sci. Lett.* 96, 119-133 (1989).
- [22] T. M Sushchanskaya, A. A. Dervits, E. P Lagutina, and VA. Kiryukhin, "Hydrogen isotope composition of water in fluid inclusions from quartz with reference to genesis of tin deposit (Solnechnoe deposit, Khabarovsk Krai)," *Geokhimiya* (5), 737-742 (1991).
- [23] M. Trieloff, J. Kunz, D. A. Clague, D. Harrison, and C. J. Allègre, "The nature of pristine noble gases in mantle plumes," *Science* 288, 1036-1038 (2000).
- [24] A. B. Verchovsky, M. A. Sephton, I. P. Wright, and C. T. Pillinger, "Separation of planetary noble gas carrier from bulk carbon in enstatite chondrites during stepped combustion," *Earth Planet. Sci. Lett.* 199, 243-255 (2002).