

ON THE METHODS OF ISOTOPIC THERMOMETRY BY THE EXAMPLE OF SODALITE - BEARING MINERAL ASSEMBLAGES

Ustinov V.I. (GEOKHI RAS), Kotelnikov A.R. (IEM RAS), Grinenko V.A. (GEOKHI RAS)

Grinenko@geokhi.ru; Fax: (495) 938-20-54 Phone: (495) 939-70-87

Key words: isotopes, oxygen

The comparison of the data obtained by the oxygen and sulfur isotopic geothermometers is very important methodically for the estimates of mineral assemblages temperature formation comprised of silicates, carbonates, sulfates and sulfides. The coincidence of temperature formation in relation to silicates (carbonates) with that of sulfur - bearing minerals indicates the synchronous formation of these minerals, being the instrument of geothermometry.

Here we report the complex method based on the combined application of monomineral oxygen - isotopic geothermometer (sulfate - sodalite) along with two infrastructural (oxygen - isotopic and sulfur - isotopic) geothermometers.

Three different combinations of geothermometers were used:

Infrastructural (sulfate - sodalite) + infrastructural (sulfate sodalite group -sulfide (FeS);

Infrastructural for the three mineral assemblages: Cl- sodalite (Cl - sod) - biotite (Bi) - amphibole (Am);

Infrastructural feldspar (Fsp) - pyroxen (Cpx) + infrastructural: sulfate sodalite group - sulfide (FeS).

The samples for our studies were taken from the Lovozero alkaline massif (C – 61, C-3, 904/908; Kolo peninsula) and Tikshezero (158 – 203.158 - 200) alkaline massif.

In the sample C-61 the following values were found: $\Delta^{18}\text{O} = + 3.4\text{‰}$ corresponding to the monomineral isotopic geothermometer for the sulfate sodalite of 700°C [1].

The mineral paragenetic assemblage of sodalite ($\delta^{34}\text{S}=+5.9\text{‰}$) and sulfide ($\delta^{34}\text{S} = - 0.3 \text{‰}$) is an indication of its formation at 780°C . These results were obtained by use of two independent isotopic geothermometers showed the synchronous high - temperature formation of silicates and sulfides.

In the sample 158-203 the oxygen isotopic composition of three mineral assemblage (Bi-Cl-sod.-Am) was determined in two mineral pairs (Cl-sod. - Bi and Cl-sod.-AM) and showed rather near temperature values, being 510 and 540°C correspondingly. The sample on question has no mineral pairs which could be used as mineral geothermometers, so the mineral formation temperature was estimated by sample 158-200 located at 3 m above in the bore hole. Isotopic geothermometer determination corroborated our assumption.

The sample 904/98 was characterized by the value $\Delta^{18}\text{O} = 2.9 \text{‰}$ determined for the mineral pair Fsp - Cpx corresponding to 520°C referenced to the named isotopic geothermometer. According to the sulfur isotopic geothermometer the mineral formation temperature was evaluated as 500°C . Thus, the consistent temperature data were obtained by use of two independent isotopic geothermometers.

In the sample C-3 the mineral pair Ne - Cpx was used for the temperature determination and showed the value of 480°C being within the temperature range established by mineral geothermometers.

The sample 158 -200 showed a great difference of values obtained by oxygen and sulfur isotopic geothermometers. Value $\Delta^{18}\text{O} = 1.6 \text{‰}$ for Bi - Am mineral pair is corresponding to 100°C , whereas $\Delta^{34}\text{S} = 14.4 \text{‰}$ for sulfate group of sodalite and sulfide gives the temperature data of 440°C . Such a discrepancy could be interpreted as a result of silicate transformation under the influence of some posterior processes namely the contribution of meteoric waters in the hydrothermal processes. The isotopic geothermometry indicated the high temperature origin of sodalite - bearing mineral assemblages characterized by wide temperature range ($480 - 780^{\circ}\text{C}$). The similar data of the temperature interval were obtained also by the mineral geothermometers.

A new complex method of temperature conditions was performed on the base of infra - and intra-structural fractionation of oxygen isotopes in sodalite- bearing assemblages and paragenetic minerals as well as sulfur isotopes in sodalite sulfate group and paragenetic sulfides.

Table. Isotopic data of sodalite-bearing assemblages

№	$\delta^{18}\text{O}, \text{‰}$								$\delta^{34}\text{S}, \text{‰}$			
	Cl - sod	Fsp	Ne	Cpx	Bi	Am	$\Delta^{18}\text{O}$	T, °C	SO ₄ Sod	FeS	$\Delta^{34}\text{S}$	T, C ***
c-61								700	5.9	-0.3	6.2	780
c-3			9.0	6.5			2.5	480*				500
904/98		8.7		5.8			2.9	520	7.6	-3.1	10.7	570
158-200					2.1	3.7	1.6	100**	14.4	+1.1	13.3	440
158-203	8.7				5.5	5.8	3.1	520				

The work has been supported by RFBR, grant № 04-05-64706

Reference

1. Устинов В.И., Котельников А.Р., Гриненко В.А. Температурный диапазон формирования содалитсодержащих ассоциаций // Геохимия. 2006. №2. СС. 230-232.

Electronic Scientific Information Journal "Herald of the Department of Earth Sciences RAS" № 1(24) 2006

ISSN 1819 – 6586

Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2006

URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2006/informbul-1_2006/izotop-6e.pdf

Published on July, 1, 2006

© Herald of the Department of the Earth Sciences RAS, 1997-2006

All rights reserved