



Chemical analysis of fluid inclusions in quartz (Madan ore field, Bulgaria)

Химически анализ на флуидни включения в кварц (Маданско рудно поле, България)

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Abstract. Флуидните включения в мадански кварцови кристали (находища Крушев дол и Южна Петровица) са изследвани чрез метода на водните извлеци, съчетан с атомноабсорбционно определяне (за водната фаза на включенията) и масспектрално определяне на летливите компоненти след първоначално стриване или декрепитиране на минералната проба във вакуум. Сравнени са 3 различни температурни програми (линейна, стъпаловидна и „шок“) за отваряне на флуидните включения във вакуум.

Key words: fluid inclusions, quartz, Madan ore field, temperature program, masspectrometry

Masspectral analysis of the volatiles released from fluid inclusions after crushing in vacuum

A carefully cleaned quartz sample of $m = 0.5 \div 1.0$ g was crushed in a vacuum device connected with the gas analysing system. The quantities of the released gases were detected masspectrometrically by the method of the internal standard (Ar^{40}) and the mass of the collected water was determined manometrically. The following results were obtained when 1g quartz sample from Krushev Dol ore deposit, was subjected to analysis (Table 1):

Table 1. Results from the masspectral analysis of gaseous mixture of 1 g crushed quartz from Krushev Dol ore deposit

	CO_2	O_2	N_2	CH_4	H_2
Volume, μl	0.73	-	0.064	0.12	1.12
Quantity, μmol	0.0327	-	0.003	0.005	0.050

The mass of the measured water was $m(\text{H}_2\text{O}) = 31 \mu\text{g}$, which is $n(\text{H}_2\text{O}) = 31 / 18 = 1.72 \mu\text{mol}$.

For this quartz the following mol ratio (mol concentration of CO_2) was evaluated:

$n(\text{CO}_2) / n(\text{H}_2\text{O}) = 0.0327 \mu\text{mol} / 1.72 \mu\text{mol} = 0.019 \text{ mol/mol}$.

EGA-MS analysis of the volatiles released from the fluid inclusions

An Evolved Gas Analysis (EGA) comprising masspectral determinations of the volatiles released from fluid inclusions was utilized. The fluid inclusions (Krushev dol deposit) were opened by decrepitation in vacuum. Three different types of temperature programs were applied for opening of the inclusions:

1) Linear temperature program — the sample was heated in a vacuum gradually from 20°C up to 600°C with a heating rate of 10 grad/min; the peak $m/z = 44$ (CO_2) was monitored.

2) Step-by-step temperature program — the temperature in the reactor was increased for 5 min up to 100, 200, 300, 400, 500 or 600°C respectively. After every single heating step a masspectral analysis was performed.

3) Thermal “shock” — the sample in the reactor was heated for 66 sec up to 400 or 600°C .

Table 2. CO_2 -mol concentrations in the fluid inclusions in quartz, Yuzhna Petrovitsa ore deposit

Quartz generations	$\text{CO}_2/\text{H}_2\text{O}$ (mol/mol) – with blank correction
pre-ore	0.010
syn-ore	0.016
post-ore	0.013

Table 3. Mol ratios for X/Na (X = K, Ca, Mg) in the fluid inclusions from quartz, Krushev Dol and Yuzhna Petrovitsa ore deposits

Quartz generations	K/Na (mol/mol)	Ca/Na (mol/mol)	Mg/Na (mol/mol)
<i>Yuzhna Petrovitsa</i>			
pre-ore	0.110	0.025	0.0016
	0.120	-	0.0025
syn-ore	0.070	0.035	0.0036
	0.110	0.027	0.0032
	0.097	0.027	0.0040
post-ore	0.100	0.025	0.0027
	0.080	0.028	0.0019
<i>Krushev Dol</i>			
decrepitation	0.070	0.019	0.0042
crushing	0.090	0.019	0.0061

In all cases the method of the internal standard (Ar^{40} as a tracer) was applied for the evaluation of the results. During the heating process the water released from the inclusions was trapped at $-117^{\circ}C$ and later was determined manometrically. All the three programs lead to statistically equal results and finely the “thermal shock” (heating up to $600^{\circ}C$ for 66 sec) was preferred for further investigations.

Atomic Absorption Analysis of water leachets obtained by decrepitation of quartz samples

The chemical analysis of the liquid phase in the fluid inclusions in the quartz mentioned above was per-

formed for mol ratio determination (K/Na, Ca/Na and Mg/Na) (Kotzeva et al., 2004). AAA after decrepitation of the inclusions was applied.

In Table 3 the mol ratios results for the fluid inclusions in quartz, both from Krushev Dol and Yuzhna Petrovitsa ore deposits are compared.

References

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