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TITANIUM MINERALIZATION OF THE STARA GÓRA DEPOSIT (KACZAWSKIE MOUNTAINS, POLAND) AND ITS CRYSTALLIZATION CONDITIONS

The polymetal deposit of Stara Góra is situated in the south-eastern part of the Kaczawskie Mountains, 20 km NE from Jelenia Góra, near the small village called Radzimowice. It is developed within the pre-Paleozoic Radzimowice schists accompanied by the rhyolites, rhyodacites and trachytes. The medium- to fine-grained granite occurs close to the deposit (Machowiak and Muszyński 2000). The deposit consists of several ore veins. These veins have are parallel with W-E strike. The vein dips are steep (about 60-90^o) usually directed to the North. The vines have rich polymetal mineralization (Manecki 1965, Mikulski 1999). Ore minerals precipitated in three stages each of different chemical composition of the mineralizing fluids. These stages were divided by episodes of cataclasis.

X-ray diffraction patterns of titanium oxide minerals were recorded CP 120 INEL microcapilary diffractometer with Co source and a quartz monochromator (λ=1,78524).

Double-polished preparations 0,1-0,5 mm thick were used for the fluid inclusions studies. The heating runs were performed by means of the Fluid Co., Inc. (USA) heating/freezing microscope stage with a measurement accuracy of ±1^{o}C, whereas the accuracy of the freezing runs was ±0.1 to ±0.2^{o}C. Temperature and pressure were determined by standard methods (Kozłowski 1984, Roedder 1984).

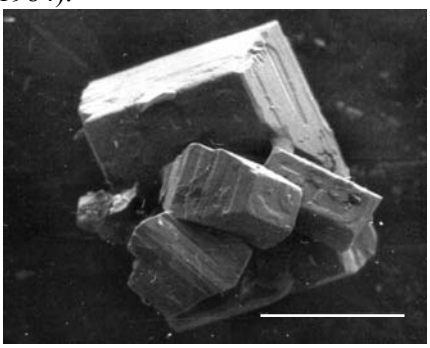

Fig. 1. SEM image of anatase (bar 2 mm).

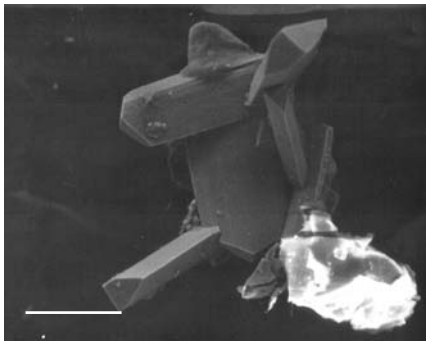

Fig. 2. SEM image of brookite (bar 1 mm).

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Minerals of titanium (anatase, brookite, rutile) occur in few centimetres thick, veins with quartz and dolomite. Arsenopyrite and chalcopyrite occur with titanium minerals.

Anatase forms individual euhedral crystals with faces {001} and {111} or clusters of several crystals. The crystals are black and reach up to 3 mm in length (Fig.1). They grew on quartz or formed inclusions in massive dolomite. Sometimes anatase formed intergrowths with brookite and rutile. In the reflected light microscope anatase has grey colour. Anisotropy is masked by very strong internal reflections (from white to brown). In thin sections anatase is brown and has pleochroism from yellow to brownish.

Small, tabular crystals with striated faces {100}, were found in dolomite veins, identified as brookite. It forms up to 2 mm honey-brown crystals with adamantine luster (fig.2). Often the crystals are terminated on both sides. This mineral is usually embedded in massive dolomite, rarely grew with anatase on quartz. In the reflected light microscope it is grey and has brownish internal reflections. In thin sections brookite is yellow or brown-yellow and has deep-yellow to red-brown pleochroism.

Rutile occur as small, up to 0,03 mm acicular crystals. Rutile crystallized on brookite and within in quartz. Sometimes rutile replaced brookite crystals. In thin sections rutile is red-brown and has weak pleochroism.

From the investigations of fluid inclusions in the quartz bearing titanium minerals, the real temperatures and pressures of their crystallization have been determined (Tab.1).

Tab. 1. Chemical composition and physical properties of the investigated fluid inclusions

Mineral	Type of inclusions							Temp. of crystallization [^oC]	Pressure of crystallization [bar]
	Aqueous inclusion filling solution					CO_2			
	Th [^oC]	Salinity [%eq. NaCl]	NaCl	$CaCl_2$*	KCl*	Th [^oC]	Density [g/cm^3]		
quartz	227	5,9	75	10	15				
quartz	197	6,2	70	20	10			} 320	} 1300
guartz						22,4	0,750		
quartz	226	6,9	71	15	14				
quartz	187	6,0	71	17	12			} 290	} 1200
quartz						22,0	0,755		
quartz	219	6,5	75	12	13				

* - percent of total salts

The obtained values are characteristic for the first stage conditions of crystallization of the Stara Góra deposit, which have been determined by investigation of fluid inclusions in quartz, dolomite and calcite. Sample of these minerals have been collected from all ore veins. At the first stage of mineralization (temperature 290 – 320^{o}C, pressure 1200 – 1300 bar) the minerals of titanium crystallized with pyrite, arsenopyrite and quartz(fig. 3). At later stages of

mineralization, at lower temperatures and pressures other minerals precipitated (chalcopyrite, sphalerite, tetrahedrite, bournonite, boulangerite, galena etc.).

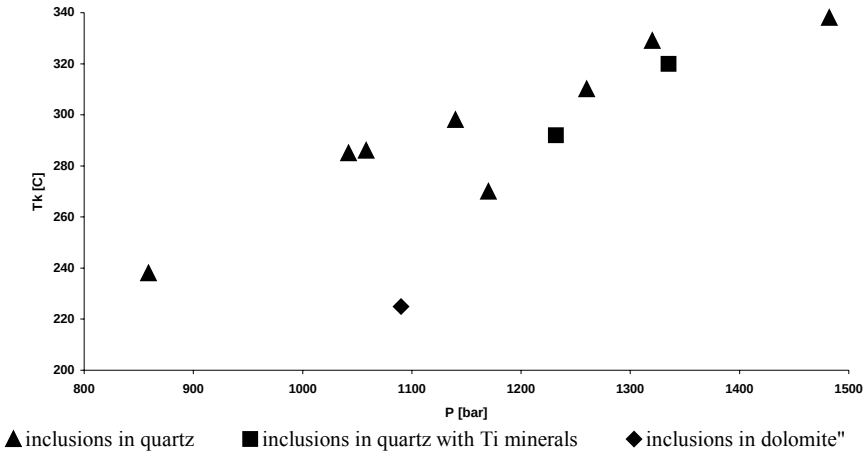

Fig. 3. Temperatures and pressures of the first stage mineral crystallization.

Presence of the titanium mineralization at the first stage of formation of the ore veins is probably connected with occurrence of the minerals of molybdenum, tungsten and tin (Sylwestrzak and Wołkowicz 1985), all developed from the high-temperature solutions.

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