



You have downloaded a document from  
**RE-BUŚ**  
repository of the University of Silesia in Katowice

**Title:** SEM studies of ore minerals in skarns from Garby Izerskie, Karkonosze-Izera Block, South-Western Poland

**Author:** Maciej Rybicki, Łukasz Karwowski, Kamila Banasik

**Citation style:** Rybicki Maciej, Karwowski Łukasz, Banasik Kamila. (2013). SEM studies of ore minerals in skarns from Garby Izerskie, Karkonosze-Izera Block, South-Western Poland. "Contemporary Trends in Geoscience" (Vol. 2 (2013), s. 61-66), doi 10.2478/ctg-2014-0009



Uznanie autorstwa - Użycie niekomercyjne - Bez utworów zależnych Polska - Licencja ta zezwala na rozpowszechnianie, przedstawianie i wykonywanie utworu jedynie w celach niekomercyjnych oraz pod warunkiem zachowania go w oryginalnej postaci (nie tworzenia utworów zależnych).



UNIwersYTET ŚLĄSKI  
W KATOWICACH



Biblioteka  
Uniwersytetu Śląskiego



Ministerstwo Nauki  
i Szkolnictwa Wyższego

MACIEJ RYBICKI<sup>1</sup>, ŁUKASZ KARWOWSKI<sup>1</sup>,  
KAMILA BANASIK<sup>1</sup>

<sup>1</sup>Faculty of Earth Science, University of Silesia,  
Bedzinska Str. 60, 41-200 Sosnowiec. E-mail: maciej.  
rybicki@us.edu.pl, lukasz.karwowski@us.edu.pl,  
kbanasik@us.edu.pl

## SEM studies of ore minerals in skarns from Garby Izerskie, Karkonosze-Izera block, south-western Poland

### KEY WORDS:

SEM, bismuth telluride, acanthite,  
native bismuth, native gold,  
native silver, skarns, Garby Izerskie.

### ABSTRACT

In "Stanisław" quarry, that is located on Garby Izerskie, ore minerals-bearing calc-silicate skarns were found in 2009. The samples were studied using microscopical method of reflected light and scanning electron microscopy (SEM). Based on SEM study, the predominant ore minerals in investigated samples are chalcopyrite, pyrrhotite, bismuth telluride and native bismuth. Moreover, acanthite, native gold and native silver were also identified. Our studies are the first report of above mentioned minerals from the Garby Izerskie area.

**Introduction**

The exocontact skarns from Garby Izerskie have been already studied in details from a petrogenetic point of view (Kozłowski 1978; Fila-Wójcicka 2000), but occurrence of ore minerals in this rock has not been sufficiently described so far. The skarns from Garby Izerskie, which occur as intercalations in hornfelsed schists, are the high-temperature calc-silicate varieties, with late silica and fluorine metasomatism (Fila-Wójcicka

2000). During studies on pyrrhotite in calc-silicate skarns from Garby Izerskie (Rybicki 2011), more precisely unidentified bismuth telluride was found among opaque minerals presented in the skarns (Rybicki 2012). This paper focuses on ore minerals, which were found calc-silicate skarns from Garby Izerskie, and were investigated using scanning electron microscope (SEM).

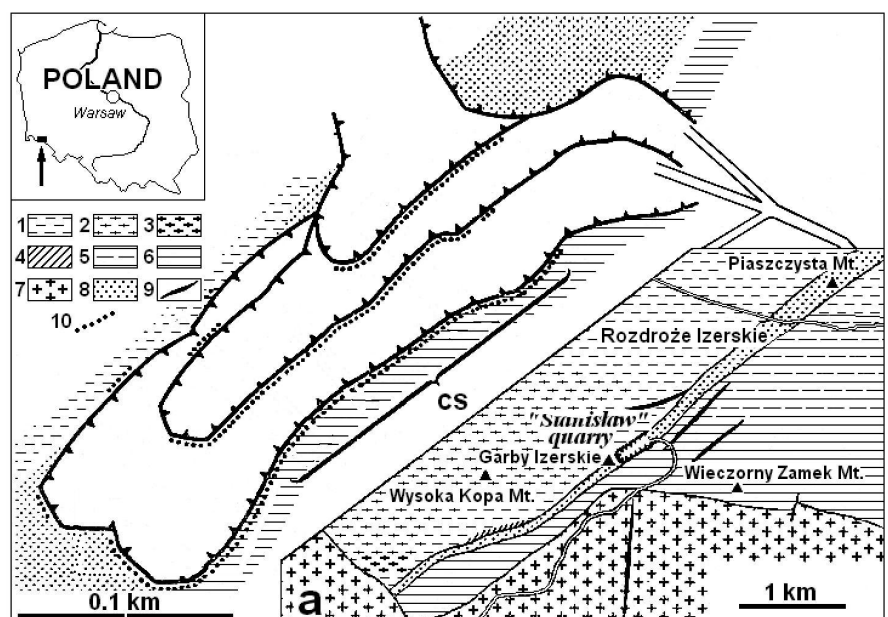
**Geological setting**

The investigated area is the “Stanisław” quarry, located in the Garby Izerskie Zone within the boundary zone of the Karkonosze massif and the metamorphic Iżera rock series (Fig. 1). The SE wall rocks are represented by laminated biotite-quartz hornfelses with andalusite and pinite (Szałamacha & Szałamacha 1966), and with intercalations of skarns (Kozłowski 1978, Fila-Wójcicka 2000), whereas the NW wall rocks are mostly augen gneisses, granite-gneisses and blastomylonitic gneisses (Kozłowski & Metz 2004). The Garby Izerskie Zone is mineralised with quartz (Kozłowski 1978), and a continuous increase in quartz content can be observed in

both the gneisses and hornfelsed schists toward the centre of this zone, to form an almost monomineralic quartz rock (Kozłowski 1978). The rocks of the Garby Izerskie Zone are cut by non-silicified granitoid apophyses. The skarns, fractured hornfelsed schists and granitoid apophyses were subjected to the activity of F-bearing solutions (Kozłowski 1978). Garby Izerskie fault zone is connected with a tectonic unit of the Sudetes Mountains, named Karkonosze – Iżera block, consisted of the Karkonosze granite massif and its metamorphic envelope – Iżera area (Mazur 2002). The Karkonosze massif is an intrusion of Variscan age (Kozłowski 1978).

Fig. 1. Geological map of Iżerskie Garby Zone (a) and “Stanisław” quarry map (after Kozłowski & Metz 2004).

- 1 – Iżera gneiss,
- 2 – granite gneisses,
- 3 – porphyritic granite gneisses;
- 4 – blastomylonitic gneisses;
- 5 – hornfels with cordierite;
- 6 – biotite hornfels;
- 7 – Karkonosze granite;
- 8 – quartz vein;
- 9 – vein rocks;
- 10 – granite occurrence; cs – outcrop of skarns.



### Material and methods

4 samples of calc-silicate skarns containing ore minerals were collected during the field works in "Stanislaw" quarry in 2009. Mineralogical studies were multistage. Polished sections were studied by routine microscopical methods of reflected light and using scanning electron microscopy (SEM) in Laboratory of Scanning Microscopy at Faculty of Earth Sciences, University of Silesia with the use of environmental analytical microscope Philips ESEM XL30/TMP equipped with detector EDS (Energy Dispersive Spectrometer) / EDAX Sapphire type in low-voltage regime (low vacuum to 1 Torr).

In this study the following abbreviations are routinely used:

Ac – acanthite;  
 Ag – native silver;  
 Au – native gold;  
 Bi – native bismuth;  
 Bi<sub>2</sub>Te<sub>3</sub> – unknown bismuth telluride;  
 Cal – calcite;  
 Ccp – chalcopyrite;  
 Fl – fluorite;  
 Po – pyrrhotite;  
 Qtz – quartz;  
 Wo – wollastonite.

### Results

The microscopical study in reflected light was used as a preliminary method and on its basis, polished sections with the highest amount of ore minerals were selected for further analysis. SEM study shows that rock-forming minerals in tested samples are mainly fluorite (Fig. 3b, d, f), calcite (Fig. 3b, d, f), wollastonite (Fig. 3c, f) and quartz (Fig. 3e).

All ore minerals are accessory phases. They occur in irregular forms and fill the spaces between rock-forming phases. Among ore minerals, chalcopyrite is the predominant phase (Fig. 2d, Fig. 3a, b, d, e, f). Chalcopyrite crystals are up to 300 µm long and 150 µm width. The other ore mineral, common in studied samples, is bismuth telluride, which has been

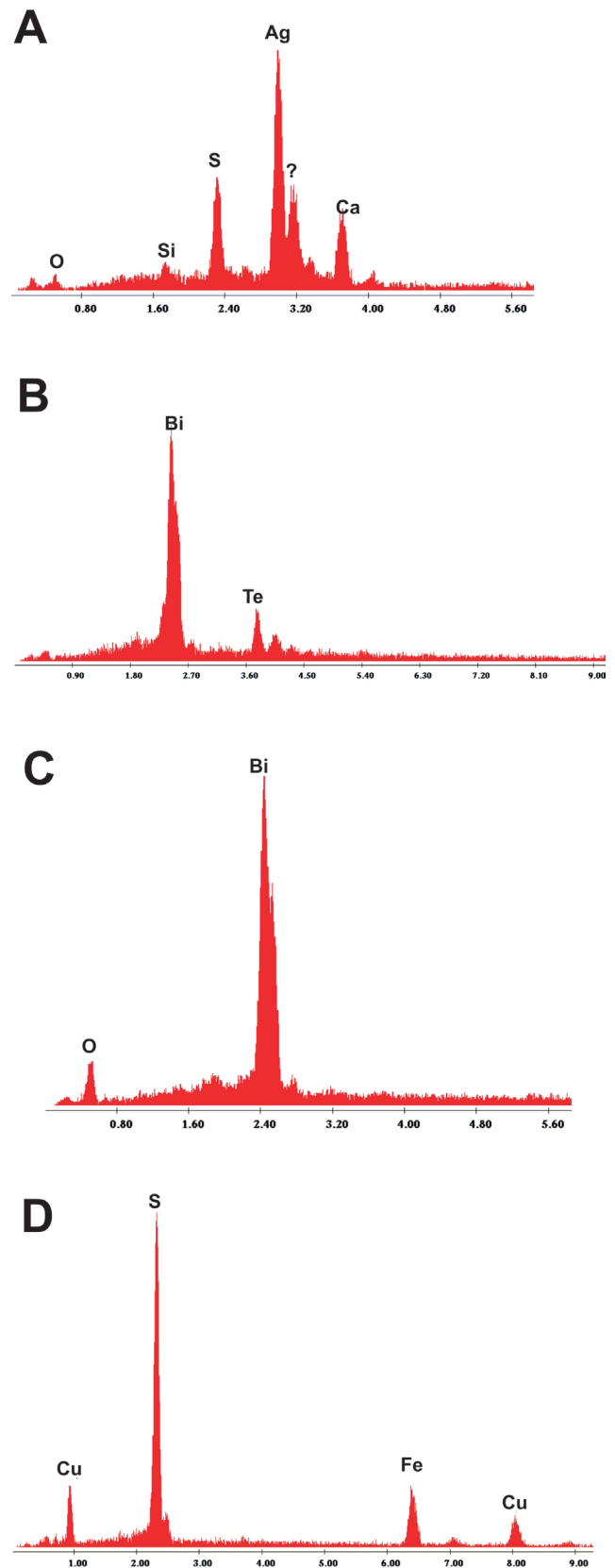
described previously by Rybicki (2012) (Fig. 2b, Fig. 3a, b, c, e, f). Bismuth telluride tends to form grains up to 200 µm long and 50 µm width. Native bismuth occurs as a grains up to 100 µm long and 80 µm width (Fig. 2c, Fig. 3a, d), while pyrrhotite forms monoclinic crystals up to 100 µm long and 100 µm width (see also Rybicki 2011) (Fig. 3b).

The other ore minerals found in studied samples are:

- (1) acanthite, which tends to form very small grains in wollastonite-fluorite matrix (Fig. 2a, Fig. 3c),
- (2) native gold, which occurs with acanthite (Fig. 3c),
- (3) and native silver vein in fluorite (Fig. 3c).

Fig. 2. EDS spectrum for:

- A – acanthite and wollastonite;
- B – bismuth telluride;
- C – native bismuth;
- D – chalcopyrite.





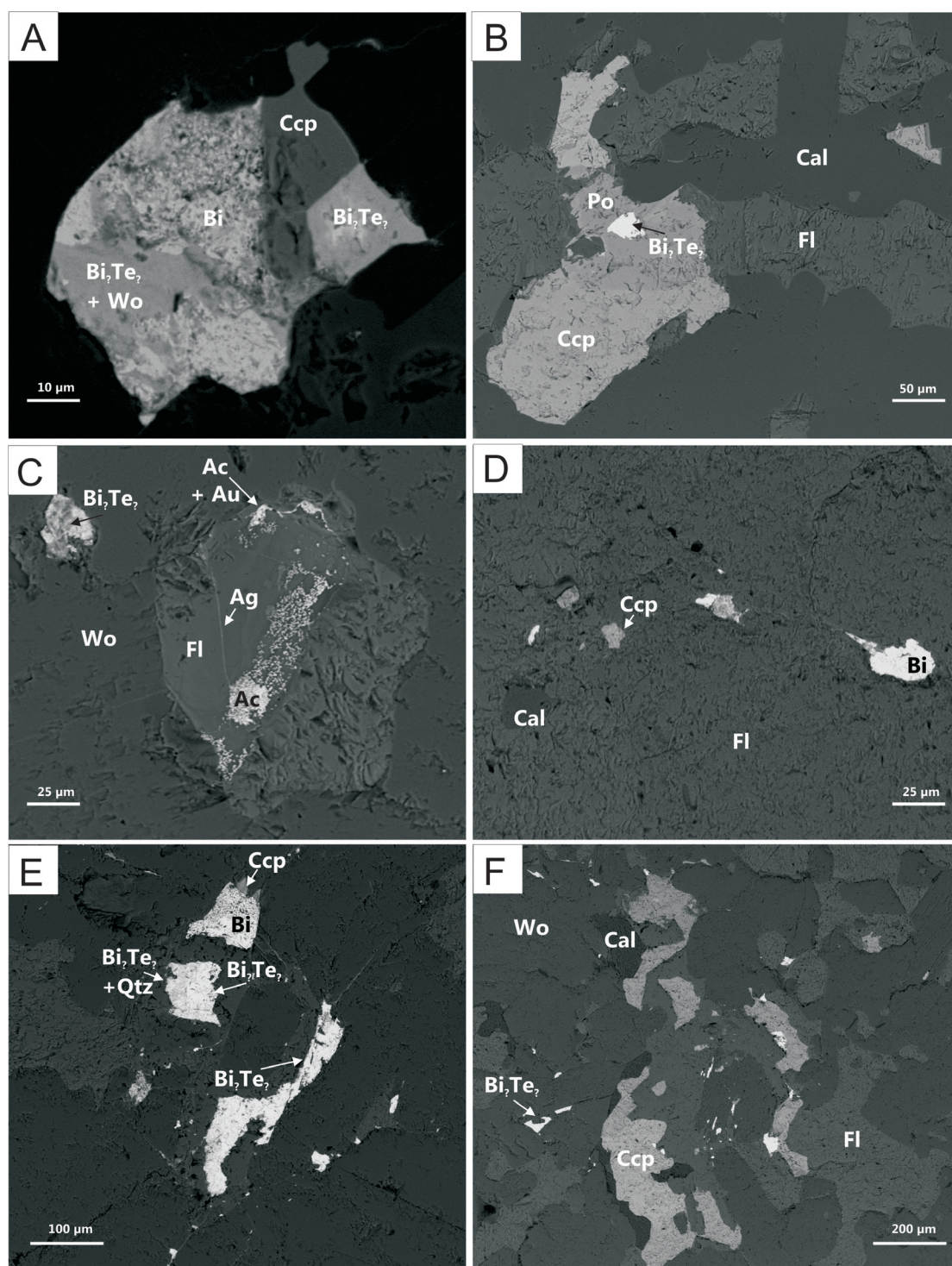


Fig. 3. SEM images of studied samples (BSE): A) Native bismuth among chalcopyrite and bismuth telluride grains and wollastonite; B) Bismuth telluride with chalcopyrite and pyrrhotite mineralization among calcite and fluorite; C) Acanthite with native gold and native silver vein in fluorite and wollastonite mineralization with bismuth telluride; D) Native bismuth, chalcopyrite and calcite in fluorite matrix; E) The aggregation of native bismuth and bismuth telluride with quartz; F) Chalcopyrite and bismuth telluride among wollastonite, fluorite and calcite mineralization.

SEM studies of ore minerals in skarns from Garby Izerskie, Karkonosze-Izera block, south-western Poland

### Conclusions

The main ore minerals in calc-silicate skarns from Garby Izerskie are chalcopyrite ( $\text{CuFeS}_2$ ), monoclinic pyrrhotite ( $\text{Fe}_7\text{S}_8$ ) (see also Rybicki 2011) and acanthite ( $\text{Ag}_2\text{S}$ ). Other common phases are bismuth minerals (bismuth telluride and native bismuth). Moreover, small amounts of native silver and native gold have been noticed.

All phases described in this study have low-temperature, hydrothermal origin. They crystallized during the latest stage of the formation of skarns, which falls on fluorine metasomatism (Fila-Wójcicka 2000). The occurrences of acanthite, native silver and native gold are the first reports of those minerals in studied area.

### Acknowledgements

Author would like to thank Eligiusz Szełęg for his support during the field work and collection of samples.

### References

- Fila-Wójcicka E. (2000) Petrogenesis of the calc-silicate skarns from Garby Izerskie, Karkonosze-Izera block. *Acta Geol. Polon.*, 50, 211–222.
- Kozłowski A., (1978) Pneumatolytic and hydrothermal activity in the Karkonosze-Izera block. *Acta Geol. Polon.* 28, 171–222.
- Kozłowski A., Metz P. (2004) Sequence and conditions of the silicification events in the Garby Izerskie dislocation zone, Sudetes. *Mineralogical Society of Poland – Special Papers*, 24, 243–246.
- Mazur S. (2002) Geology of the Karkonosze – Izera Massif: an overview. *Mineralogical Society of Poland – Special Papers*, 20, 22–34.
- Rybicki M. (2011) Badania mossbauerowskie siarczków żelaza grupy pirotynu z wybranych lokalizacji Sudetów oraz teorytów. *Interdyscyplinarne zagadnienia w górnictwie i geologii*, 2, 129–137 (in polish).
- Rybicki M. (2012) Preliminary data on bismuth telluride from Izerskie Garby Zone, Karkonosze-Izera Block, southern west Poland. *Contemporary Trends in Geoscience*, 1, 63–66.
- Szałamacha M., Szałamacha J. (1966) Dislocation zone of Rozdroże Izerskie in the Izerskie Mts. *Kwartalnik Geol.*, 10, 666–688.