

ZACCARINIITE, RhNiAs, A NEW PLATINUM-GROUP MINERAL FROM LOMA PEGUERA, DOMINICAN REPUBLIC

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ABSTRACT

Zaccariniite, RhNiAs, is a new platinum-group mineral discovered in the Loma Peguera ophiolitic chromitite, Dominican Republic. The mineral forms anhedral grains (1–20 µm in size) and occurs intergrown with garutiite, in association with hexaferrum, Ru-Os-Ir-Fe alloys, Ru-Os-Ir-Fe oxygenated compounds, and chromite. Zaccariniite is opaque and has a metallic luster and a grey streak. The mineral is brittle, with no cleavage. Values of VHN₅ (10 indentations on different grains of synthetic RhNiAs) fall between 166 and 286 kg/mm², with a mean value of 218 kg/mm², corresponding to a Mohs hardness of approximately 3.5–4. Under plane-polarized reflected light, the mineral is white with brownish to pinkish tints, has moderate to strong bireflectance, a strong white to pinkish brownish white pleochroism, and strong anisotropy, with rotation tints from orange to blue–green; it exhibits no internal reflections. Reflectance values of zaccariniite in air (R₁, R₂ in %) are: 49.4, 49.4 at 470 nm; 52.4, 53.2 at 546 nm; 54.2, 53.2 at 589 nm; and 56.6, 53.3 at 650 nm. Three electron microprobe analyses of natural zaccariniite gave an average composition of: Rh 41.77, Os 0.51, Ir 0.64, Ru 0.46, Pd 0.34, Ni 23.75, Fe 0.53, As 27.84, S 0.10, for a total of 96.09 wt.%, corresponding to the empirical formula (Rh_{1.01}Os_{0.01}Ir_{0.01}Ru_{0.01}Pd_{0.01})_{Σ1.05}(Ni_{1.00}Fe_{0.02})_{Σ1.02}(As_{0.92}S_{0.01})_{Σ0.93} based on three atoms. The average result of twenty-eight analyses of synthetic zaccariniite is: Rh 44.57, Ni 24.50, and As 31.82 total 100.88 wt.%, corresponding to Rh_{1.02}Ni_{0.98}As_{1.00}. The mineral is tetragonal, belongs to space group *P4/nmm* with lattice parameters *a* = 3.5498(1), *c* = 6.1573(2) Å, *V* = 77.59(1) Å³, *Z* = 2, and crystallizes with the Cu₂Sb structure type. The strongest lines in the X-ray powder-diffraction pattern of synthetic zaccariniite [*d* in Å(*hkl*)] are: 2.5092(40)(110), 2.3252(100)(111,102), 1.9453(51)(112), 1.7758(80)(103,200), 1.2555(40)(213,220), 1.1044(22)(302,311), 1.0547(23)(312), 0.9730(42)(215). The new Rh-Ni arsenide is named after Federica Zaccarini in recognition of her important contributions to the mineralogy of platinum-group elements.

Keywords: zaccariniite, platinum-group mineral, Rh-Ni arsenide, electron-microprobe data, reflectance data, synthetic RhNiAs, X-ray diffraction data, Cu₂Sb, crystal structure, Loma Peguera, Dominican Republic

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INTRODUCTION

The new mineral species was discovered in a polished section of an aggregate of PGM 20×40 μm in size, in chromite, obtained from a heavy-mineral concentrate from the Loma Peguera ophiolitic chromitite, Dominican Republic. It was first described as an unnamed RhNiAs phase by Zaccarini *et al.* (2009) in intergrowths with garutiite, in association with hexaferrum, Ru-Os-Ir-Fe alloys, and Ru-Os-Ir-Fe oxygenated compounds in chromite, from the Loma Peguera ophiolitic chromitite, Dominican Republic. The same phase had been also observed, as an unnamed phase, in an alluvial occurrence of the ophiolitic belt in the Koryak-Kamchatska fold region, former USSR by Rudashevsky *et al.* (1983); in gold placer in the upper Chindwin area of the northern Burma by Hagen *et al.* (1990); in chromitite from the Thetford Mines area, Quebec (Canada) by Corrivaux & Laflamme (1990); in the Onverwacht pipes in the Bushveld complex (Rudashevsky *et al.* 1992); in the Guli chromitite in Russia by Malich & Rudashevsky (1994); in the Vourinos

complex (Greece) by Garuti & Zaccarini (1997) and Grammatikopoulos *et al.* (2011); in the Ray-Iz ophiolite complex, Polar Urals (Russia) by Garuti *et al.* (1999); in rivers draining the eastern Bushveld complex (South Africa) by Oberthür *et al.* (2004); in Nizhny Tagil in the Urals (Russia) by Augé *et al.* (2005); and in the Kempirsai ophiolite complex in Kazakhstan, by Distler *et al.* (2008).

The new Rh-Ni arsenide is named after Dr. Federica Zaccarini (born 1962), University of Leoben, in recognition of her important contributions to the mineralogy of platinum-group elements and her research on PGE deposits, especially related to mafic and ultramafic rocks.

The mineral and the mineral name have been approved by the Commission on New Minerals, Nomenclature and Classification of the IMA (CNMNC 2011-086). The holotype material (polished section) is deposited in the Mineralogical Museum of Leoben, Peter-Tunner-Straße 5, Leoben, Austria, and is registered under the catalogue number 8241.

We herein describe the properties and report on the crystal structure of zaccariniite.

OCCURRENCE AND ASSOCIATED MINERALS

Zaccariniite was discovered in a polished section in an aggregate of PGM, 20×40 μm in size, as an inclusion in chromite. The specimen comes from a heavy-mineral concentrate from the Loma Peguera chromitite, Dominican Republic (Fig. 1.). The Loma Peguera chromitites occur in the central part of the Loma Caribe peridotite in the Cordillera Central of the Dominican Republic (Proenza *et al.* 2007, Zaccarini *et al.* 2009). The mineral was obtained from a heavy-mineral concentrate by processing a *ca.* 3 kg of sample of massive chromitite using a combination of electric pulse disaggregation (EPD), and hydroseparation (HS) (*e.g.*, Cabri *et al.* 2008). The recently described mineral garutiite was discovered in the same chromitite and was obtained by the same method and procedure (for details see McDonald *et al.* 2010).

The new mineral forms anhedral grains (1–20 μm in size) and is intergrown with garutiite, in association with hexaferrum, Ru-Os-Ir-Fe alloys, and Ru-Os-Ir-Fe oxygenated compounds in chromite. An image in plane polarized reflected light of the new mineral and garutiite is shown in Figure 2.

Zaccariniite likely formed together with garutiite. These minerals are interpreted to be secondary in origin, and formed at lower temperatures during alteration of the ophiolitic host-rock (McDonald *et al.* 2010).

EXPERIMENTAL PROCEDURES

The small size of natural RhNiAs embedded in garutiite prevented its extraction and subsequent mineralogical study. Therefore, the relevant crystallographic

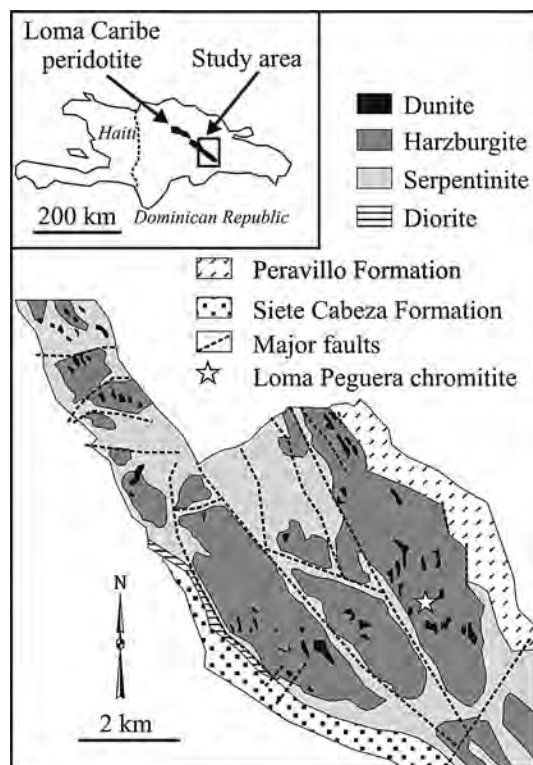


FIG. 1. Geological sketch-map of the Loma Caribe peridotite showing the sampling location at Loma Peguera, Dominican Republic, adapted from Proenza *et al.* (2007) and Haldemann *et al.* (1979).

investigations, density measurement, and determination of physical properties were performed on synthetic RhNiAs.

The synthetic RhNiAs phase was prepared using an evacuated silica-glass-tube method in the Laboratory of Experimental Mineralogy of the Czech Geological Survey in Prague. Rhodium (99.99%), nickel (99.999%), and arsenic (99.999%) obtained from Sigma-Aldrich Co. were the starting materials for the synthesis. A carefully weighed sample was loaded into the high-purity silica tube and a tightly fitting silica-glass rod was placed on top of the reagents in order to keep the charge in place and also to reduce the volume of vapor on heating. The evacuated tube with its charge was sealed and then annealed at 1200 °C for three days. After cooling in a cold-water bath, the charge was removed from the tube, ground to powder in acetone using an agate mortar, and thoroughly mixed to homogenize it. The pulverized charge was again sealed in an evacuated silica-glass tube and reheated at 800 °C for 840 hours. Temperature was controlled electronically (± 4 °C). The experimental product was rapidly quenched in a cold-water bath. The resulting product is composed of crystalline RhNiAs (*ca.* 98 wt.%) and (Rh,Ni) alloy (*ca.* 2 wt.%).

PHYSICAL AND OPTICAL PROPERTIES

Anhedral grains of zaccariniite about 1–20 μm across (Fig. 2) occur intergrown with garutiite in chromite. Synthetic zaccariniite is opaque and has a metallic luster and a grey streak. It is brittle, with no cleavage. Values of VHN_5 (10 indentations on different grains of synthetic RhNiAs) are between 166 and 286 kg/mm^2 , with a mean value of 218 kg/mm^2 , corresponding to a Mohs hardness of approximately 3.5–4. The density,



FIG. 2. Microphotograph (plane polarized reflected light, magnification 200 \times) of zaccariniite in association with garutiite.

calculated on the basis of the empirical formula of the natural material, is 10.19 g/cm^3 , and that of the synthetic material is 10.12 g/cm^3 . The density measured by weighing RhNiAs in toluene is 10.09 g/cm^3 . Under plane-polarized reflected light, zaccariniite and synthetic RhNiAs are white with brownish to pinkish tints, have a moderate to strong birefractance, strong pleochroism from white to pinkish brownish white, and strong anisotropy with rotation tints from orange to blue–green. The grains examined do not exhibit internal reflections.

Reflectance data of natural and synthetic zaccariniite were obtained in air using a Zeiss Axiotron microscope equipped with a Crystal Structures (Lanham) superstage to level the specimen and standard prior to measurement. Measurements were made in air with a J & M Tidas diode array spectrometer relative to a Zeiss WTiC standard using Cavendish Instruments Onyx software at intervals of 0.823 nm from 400 to 700 nm. The reflectance data are given in Table 1 and color values in Table 2. It was not possible to obtain data for certain R_o and R_e and the designations are therefore R1 and R2. Figure 3 shows the reflectance curves of natural and synthetic zaccariniite.

CHEMICAL DATA

Chemical analyses of natural and synthetic zaccariniite were made with a JEOL JXA 8200 Superprobe

TABLE 1. REFLECTANCE VALUES OF NATURAL AND SYNTHETIC ZACCARINIITE

λ (nm)	natural		synthetic	
	R1	R2	R1	R2
400	45.4	50.9	45.2	51.5
420	46.2	51.1	46.1	52.0
440	47.4	51.4	47.0	52.5
460	48.8	52.2	48.4	53.0
470	49.4	52.6	49.1	53.3
480	49.9	52.9	49.7	53.6
500	50.7	53.3	50.8	54.0
520	51.4	53.3	51.7	54.1
540	52.0	53.2	52.6	54.1
546	52.4	53.2	53.1	54.1
560	52.8	53.2	53.6	54.0
580	53.7	53.2	54.6	53.9
589	54.2	53.2	55.2	53.9
600	54.6	53.2	55.7	53.9
620	55.4	53.2	56.6	53.9
640	56.2	53.2	57.4	53.8
650	56.6	53.3	57.9	53.9
660	57.0	53.3	58.3	53.9
680	58.0	53.9	59.2	54.1
700	59.0	54.5	60.2	54.4

The standard wavelengths (COM) were interpolated, and are given in bold.

(Eugen F. Stumpfl Laboratory, Leoben), in wavelength-dispersion mode, operating with an accelerating voltage of 20 keV, a beam current of 10 nA, and a beam diameter of 1 μm . The following diffracting crystals were selected: PETJ for S; PETH for Ru, Os, Rh; LIF for Cu; and LIFH for Ni, Ir, and Pt. The X-ray lines used were: $K\alpha$ for S, Fe, Cu, and Ni; $L\alpha$ for Ir, Ru, Rh, and Pt; and $M\alpha$ for Os. As reference materials we used pure metals for PGE, synthetic PtAs_2 for As, NiS for Ni, and natural CuFeS_2 for Fe, Cu, and S.

The electron-microprobe results are given in Table 3. Chemical composition data of RhNiAs phases

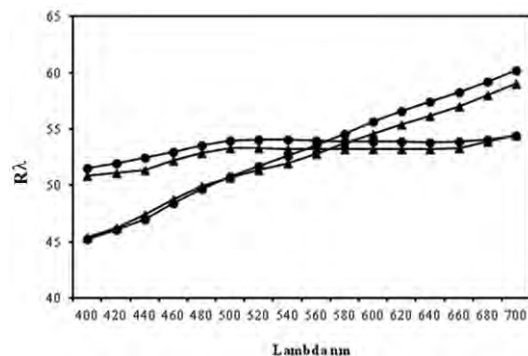


FIG. 3. Reflectance data for natural zaccariniite (triangles) compared to synthetic (circles) in air. The reflectance values ($R\%$) are plotted versus wavelength λ in nm.

reported in the literature are summarized in Table 4. The empirical formula (based on three atoms) for natural zaccariniite (average result of three analyses) is $(\text{Rh}_{1.01}\text{Os}_{0.01}\text{Ir}_{0.01}\text{Ru}_{0.01}\text{Pd}_{0.01})_{\Sigma 1.05}(\text{Ni}_{1.00}\text{Fe}_{0.02})_{\Sigma 1.02}(\text{As}_{0.92}\text{S}_{0.01})_{\Sigma 0.93}$, and for synthetic zaccariniite (average result of 28 analyses) corresponds to $\text{Rh}_{1.02}\text{Ni}_{0.98}\text{As}_{1.00}$.

CRYSTAL-STRUCTURE DATA

As no single crystals suitable for single-crystal diffraction analysis were available, the crystal structure of synthetic zaccariniite was refined from the powder X-ray diffraction data.

The X-ray diffraction pattern used for Rietveld refinement was collected in Bragg-Brentano geometry with an X'Pert Pro PANalytical diffractometer, equipped with X'Celerator detector and a $\text{CoK}\alpha$ radiation source. The data were collected in the range between 10 and $143^\circ 2\theta$; a full width at half maximum of 0.095° in 2θ was obtained at $41.75^\circ 2\theta$, indicating good crystallinity of the sample. The details of data collection and basic crystallographic properties are given in Table 5.

The crystal structure of synthetic zaccariniite was refined using the initial structure model for synthetic RhNiAs given by Roy-Montreuil *et al.* (1984). The FullProf program (Rodríguez-Carvajal 2006) was employed for Rietveld refinement. The pseudo-Voigt function was used to generate the shape of the diffraction peaks in Rietveld refinement. The background was determined by the linear interpolation between consecutive breakpoints in the pattern. The refined parameters include those describing the peak shape and width, peak

TABLE 2. COLOR VALUES FOR ZACCARINIITE

	A illuminant				C illuminant					
	x	y	Y%	λd	Pe%	x	y	Y%	λd	Pe%
x	0.458	0.449	0.46	0.448	0.321	0.312	0.324	0.312		
y	0.41	0.409	0.41	0.409	0.327	0.32	0.329	0.32		
Y%	53.4	53.2	54.2	54	52.8	53.2	53.5	54		
λd	589	579	588	577	579	568	579	567		
Pe%	8.4	1.8	10.4	1.6	5.8	1.5	7	1.3		

TABLE 3. ELECTRON-MICROPROBE DATA OF NATURAL AND SYNTHETIC ZACCARINIITE (in wt.%)

	Os	Ir	Ru	Rh	Pt	Pd	Fe	Ni	Cu	Co	S	As	Σ
Natural material (3 analyses)													
Mean	0.51	0.64	0.46	41.77	0.05	0.34	0.53	23.75	0.04	0.07	0.1	27.84	96.09
Min-Max	0.30–0.90	0.34–1.14	0.29–0.74	40.99–42.58	0–0.08	0.19–0.45	0.33–0.88	23.54–23.91	0–0.06	0.05–0.08	0.08–0.13	27.07–29.25	
σ	0.24	0.31	0.17	0.56	0.03	0.09	0.21	0.13	0.02	0.01	0.02	0.86	
Synthetic material (28 analyses)													
Mean				44.57				24.5				31.82	100.88
Min-Max				44.15–44.65				24.23–24.58				30.98–32.47	
σ				0.32				0.17				0.37	

TABLE 4. ELECTRON-MICROPROBE DATA FOR ZACCARINIITE REPORTED IN THE LITERATURE (in wt.%)

Sample	Os	Ir	Ru	Rh	Pt	Pd	Fe	Ni	Cu	Co	S	As	Total
Koryak-Kamchatska ophiolitic chromitites, Russia ⁽¹⁾													
12		0.56		43.50	0.50			24.20				30.60	99.36
Theftford mine ophiolitic chromitites, Quebec ⁽²⁾													
108A			42.30				2.20	24.30				30.90	99.70
109A			42.50				1.00	24.50				32.00	100.0
21			42.10		0.50	0.20	2.30	25.70				29.20	100.0
Gold placer in Chindwin area of northern Burma ⁽³⁾													
	0.93	2.08	1.72	40.56			0.37	21.44			1.81	29.52	98.43
Onverwacht pipe, Bushveld Complex ⁽⁴⁾													
10/13 30		3.00		37.90			4.60	23.60		1.40	2.20	21.10	93.80
Guli chromitite, Russia ⁽⁵⁾													
8		1.30		42.50	3.70		1.10	23.00	0.40			27.40	99.40
9				40.80	4.40		0.90	24.00				28.30	98.40
Vourinos ophiolitic chromitites, Greece ^(6, 12)													
VS5a-3-3 ⁽⁶⁾	0.03	10.53	0.08	25.36	7.33	3.30	1.01	19.93		0.05	0.08	27.89	95.60
V-2 ⁽¹²⁾	0.33	2.90	1.46	41.45		0.10	4.04	20.96			0.54	32.15	103.93
Ray Iz, ophiolitic chromitites, Urals ⁽⁷⁾													
2243b-2	0.81	5.30	6.41	31.28		0.61		20.39			0.66	28.60	94.06
Eastern Bushveld, nuggets, South Africa ⁽⁸⁾													
AS6392 102				41.29	1.29	4.59	0.11	23.49	2.80			26.09	99.66
Nizhny Tagil, Ural-Alaskan chromitites, Urals ⁽⁹⁾													
3VA 15 53		0.23	0.06	41.88	1.23		0.58	23.06	2.13	0.02		28.46	97.65
3VA 15 54		0.14		42.71	1.24	0.36	0.94	22.91	1.72	0.02		29.20	99.24
13VA 9 26		0.48		40.70	6.52	1.29	1.08	21.43	0.50	0.02		27.54	99.56
43-2 3 204		0.59	0.53	35.37	15.28	0.42	2.64	18.94	1.23			26.17	101.17
NT8 1 225		0.10		43.65	1.09	0.17	0.62	23.26	3.06	0.02		29.86	101.83
NT8 1 226		0.04		43.33	0.86		0.23	23.66	3.07			30.95	102.14
Kempirsai chromitites, Kazakhstan ⁽¹⁰⁾													
1				43.20				24.40				32.40	100.0
Loma Peguera, ophiolitic chromitites, Dominican Republic ⁽¹¹⁾													
6 25 5 3	0.90	1.14	0.74	42.58		0.19	0.88	23.54		0.08	0.08	29.25	99.38
6 125 4 2	0.30	0.34	0.29	41.73	0.06	0.45	0.33	23.80	0.06	0.08	0.13	27.07	94.64
6 25 4 3	0.32	0.44	0.34	40.99	0.08	0.37	0.39	23.91	0.06	0.05	0.10	27.20	94.25

¹Rudashevsky *et al.* (1983); ²Corrivaux & Laflamme (1990); ³Hagen *et al.* (1990); ⁴Rudashevsky *et al.* (1992); ⁵Malich & Rudashevsky (1994); ⁶Garuti & Zaccarini (1997); ⁷Garuti *et al.* (1999); ⁸Oberthur *et al.* (2004); ⁹Auge *et al.* (2005); ¹⁰Distler *et al.* (2008); ¹¹Zaccarini *et al.* (2009); ¹²Grammatikopoulos *et al.* (2011)

asymmetry, unit-cell parameters, fractional coordinates, and isotropic displacement parameters. In total, 16 parameters were refined. The final cycles of refinement converged to the residual factors: $R_{\text{Bragg}} = 0.069$, $R_{\text{wp}} = 0.053$ and $R_p = 0.036$. The crystal-structure data are given in Table 6, the final Rietveld plot in Figure 4, and the powder X-ray diffraction data in Table 7.

The crystal structure of synthetic RhNiAs (Roy-Montreuil *et al.* 1984) was in principle confirmed for synthetic zaccariniite, as the refined fractional coordinates do not deviate more than 0.01 from the starting values. Nevertheless, we report slightly different lattice parameters. This difference may be ascribed to the different methods of synthesis of RhNiAs.

Zaccariniite adopts the Cu_2Sb -type crystal structure (also referred as Fe_2As -type). Its unit cell contains one Ni position, one Rh position, and one As position. The

As atom is surrounded by four Ni atoms at 2.359(1) Å and five Rh atoms [$2.385(2) + 4 \times 2.597(1)$ Å] showing mon capped tetragonal antiprismatic coordination (Fig. 5a). These polyhedra share the Ni–Ni, Ni–Rh, and Rh–Rh edges forming the crystal structure of RhNiAs. As was noted by Nuss *et al.* (2006), the phases with the Cu_2Sb -type structure can be illustratively described as consisting of stacked layers. In the RhNiAs structure, the Rh and As atoms form a corrugated double layer where these atoms vary in all directions (Fig. 5b). This double layer is sandwiched by two square planar layers of atoms at position 2a, *i.e.*, the Ni atoms (Nuss *et al.* 2006). The Ni–Ni distance in this layer is 2.51 Å, which is close to the Ni–Ni distance of 2.492 Å observed in the element (Suh *et al.* 1988). The most structurally related mineral species is cuprostibite (Cu_2Sb), which shows essentially the same crystal structure as zaccariniite.

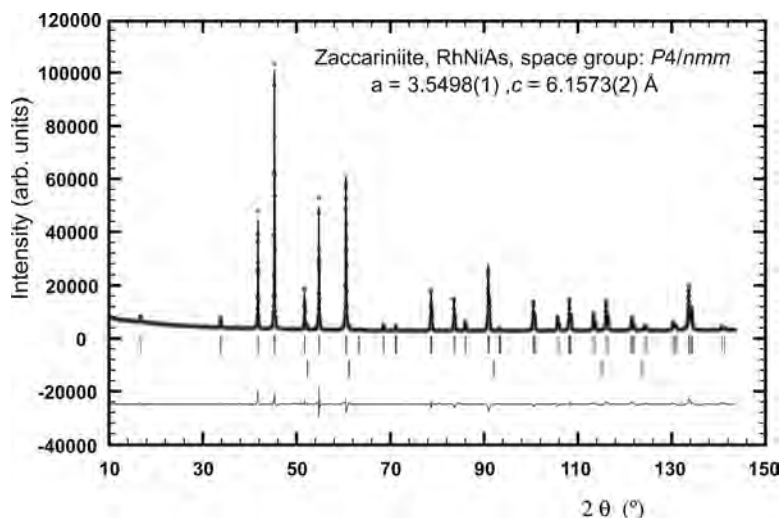


FIG. 4. The observed (circles), calculated (solid line), and difference Rietveld profiles for zaccariniite. The upper reflection marks correspond to zaccariniite, and the lower marks to a 2 mass percent (Rh, Ni) alloy impurity.

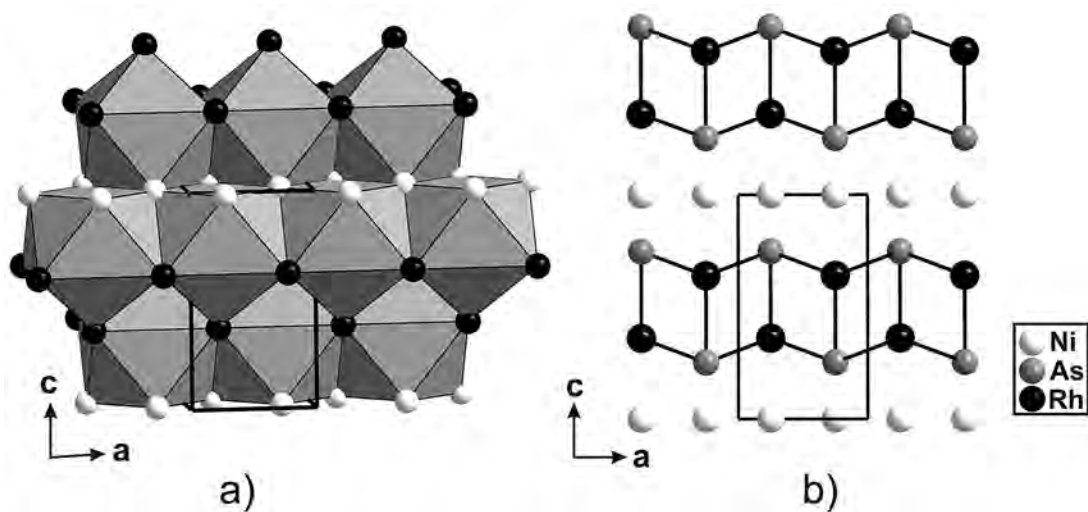


FIG. 5. The crystal structure of zaccariniite (RhNiAs). (a) Polyhedral representation showing the edge-connected $[AsNi_4Rh_3]$ polyhedra. (b) Projection on c - a plane illustrating the double layers of Rh and As atoms.

PROOF OF IDENTITY OF NATURAL AND SYNTHETIC ZACCARINIITE

The structural identity between the synthetic RhNiAs and the natural material was confirmed by the Raman spectroscopy technique. The Raman spectra of natural and synthetic RhNiAs are identical (Fig. 6).

Raman spectra were obtained using a LABRAM (ISA Jobin Yvon) instrument installed at the University of Leoben. A frequency-doubled 100 mW Nd-YAG laser with an excitation of wavelength of $\lambda = 532.6$ nm was used.

The Raman spectra, chemical identity and optical properties confirmed that the natural and synthetic

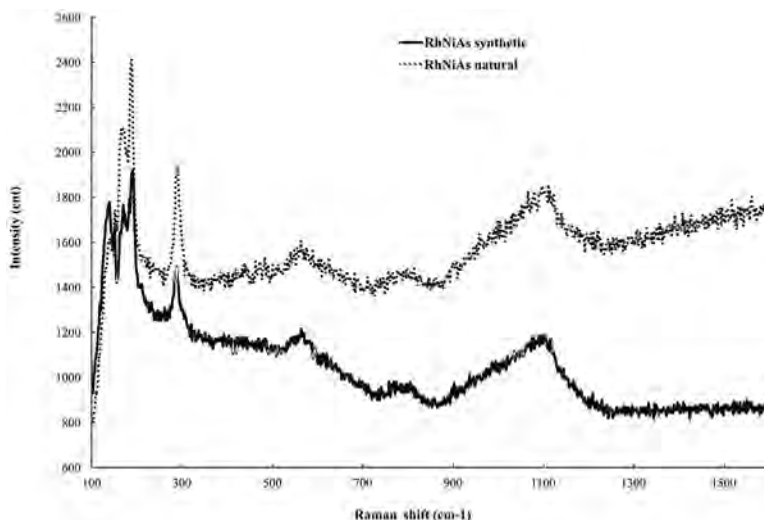


FIG. 6. Raman spectra for natural and synthetic RhNiAs (the different intensities of synthetic and natural samples is due to the different orientation of the measured grains).

TABLE 5. POWDER X-RAY DIFFRACTION EXPERIMENTAL DETAILS AND RIETVELD ANALYSIS OF ZACCARINIITE

Data collection	
Radiation type, source	X-ray, CoK α
Generator settings	40kV, 30mA
Range in 2 θ (°)	10–143
Step size (°)	0.02
Crystal data	
Space group	<i>P4/nmm</i> (No. 129)
Unit-cell content	RhNiAs, Z = 2
Unit-cell parameters (Å)	a = 3.5498(1) c = 6.1573(2)
Unit-cell volume (Å ³)	77.59(1)
Rietveld analysis	
No. of reflections	48
No. of structural parameters	5
No. of profile parameters	7
R_{Bragg}	0.69
R_{p}	0.036
R_{wp}	0.053
Weighting scheme	1/ y_0

R agreement factors defined according to McCusker *et al.* (1999).

TABLE 6. ATOMIC POSITIONS AND ISOTROPIC DISPLACEMENT PARAMETERS FOR SYNTHETIC ZACCARINIITE

Atom	Wyckoff position	x	y	z	B_{iso} (Å ²)
Ni	2a	3/4	1/4	0	0.47(5)
Rh	2c	1/4	1/4	0.3604(2)	0.25(3)
As	2c	1/4	1/4	0.7508(2)	0.21(3)

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materials are the same. Consequently, our results render legitimate the use of the synthetic phase to support the complete characterization of zaccariniite.

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TABLE 7. X-RAY POWDER-DIFFRACTION DATA FOR SYNTHETIC ZACCARINIITE (CoK α radiation). REFLECTIONS WITH INTENSITIES $\geq 1\%$ ARE SHOWN

$l_{(calc)}$	$l_{(obs)}$	$d_{(calc)}$	$d_{(obs)}$	h	k	l
1	1	6.1572	6.1508	0	0	1
3	3	3.0787	3.0773	0	0	2
1		3.0754		1	0	1
36	40	2.5101	2.5092	1	1	0
100	100	2.3258	2.3252	1	1	1
		2.3244		1	0	2
16	16	2.0524	2.0524	0	0	3
54	51	1.9454	1.9453	1	1	2
31	80	1.7768	1.7758	1	0	3
53		1.7749		2	0	0
3	3	1.5889	1.5889	1	1	3
2	3	1.5377	1.5378	2	0	2
1	21	1.4123	1.4110	1	0	4
22		1.4110		2	1	2
20	18	1.3425	1.3425	2	0	3
5	5	1.3122	1.3123	1	1	4
26	40	1.2557	1.2555	2	1	3
21		1.2551		2	2	0
1	2	1.2315	1.2314	0	0	5
21	19	1.1634	1.1634	1	0	5
12	10	1.1226	1.1225	3	1	0
7	22	1.1045	1.1044	3	0	2
16		1.1044		3	1	1
12	12	1.0707	1.0707	2	2	3
23	23	1.0546	1.0547	3	1	2
9	10	1.0251	1.0251	3	0	3
3	3	1.0118	1.0118	2	0	5
6	6	0.9858	0.9856	1	0	6
37	42	0.9730	0.9730	2	1	5
2	3	0.9499	0.9499	1	1	6

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