

Supplements to: A Solar Optical Hyperspectral Library of Rare Earth-bearing minerals, RE-Oxides, Copper-bearing minerals and Apliki mine surface samples. Sample Descriptions.

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The spectral libraries and corresponding geochemistry of the samples listed here are published via GFZ Data Services with
25 the following DOIs: <http://doi.org/10.5880/GFZ.1.4.2019.004> (REE elements, Koerting et al., 2019a),
<http://doi.org/10.5880/GFZ.1.4.2019.003> (Copper bearing minerals. Koellner et al., 2019),
and <http://doi.org/10.5880/GFZ.1.4.2019.005> (copper bearing minerals from the Apliki copper-gold-pyrite mine in Cyprus, Koerting et al., 2019b).

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35 **Table S1: Rare Earth Mineral sample name, formula, size and provenance, modified after** (Bösche, 2015; Herrmann, 2019).

Rare Earth Mineral	Formula	Mineral size	Collection Locality
Baropyrochlore. Fluorapatite	$(\text{Ba, Sr})(\text{Nb, Ti})_2(\text{O,OH})_7$	0.5 x 0.2 cm	Mina Boa Vista. Catalao. Goias/Brazil
Bastnaesite (Ce)	$\text{Ce}[\text{F} \text{CO}_3]$	3 x 1.3 cm	Zagi Mountain. Warzal Dam. Pechawar. North-West Frontier Prov./Pakistan
Gadolinit (Y). Synchysite (Y). Fluorite	$\text{Y}_2\text{Fe}_2+\text{Be}_2\text{O}_2(\text{SiO}_4)_2$	1.1 x 0.7 cm	White Cloud Pegmatite. South Platte. Jefferson Co. Colorado/USA
Monazite (Sm) incl. Monazite (Nd)	$\text{SmPO}_4. (\text{Nd,Ce, La})(\text{P, Si})\text{O}_4, \text{Ca}(\text{Ce, La})_2(\text{CO}_3)_3\text{F}_2$	0.2 x 0.2 cm	Svodovyi. Grubependity Lake. Maldynyrd Range. Prepolar Ural. Komi Republic. Russia
Parisite (Nd) incl. Parisite (Ce)	$\text{Ca}(\text{Nd, Ce, La})_2(\text{CO}_3)_3\text{F}_2$	2.6 x 1.6 cm	Mountain Pass Mine. Ivanpah Mts. San Bernardino Co. California/USA
Polycrase (Y)	$(\text{Y,Ca,Ce,U,Th})(\text{Ti,Nb, Ta})_2\text{O}_6$	0.5 x 0.1 cm	Puotevare Pegmatite. Tjalmejaure Lake. Jokkmokk Lappland/Northern Sweden
Synchysite (Y)	$\text{CaY}(\text{CO}_3)_2\text{F}$	1.5 x 2.5 cm	White Cloud Pegmatite. South Platte. Jefferson Co. Colorado/USA
Xenotime (Y) (a)	Y PO_4	0.7 x 0.3 cm	Novo Horizonte. Ibitiara. Bahia/Brazil
Xenotime (Y) (b)	Y PO_4	1.2 x 0.4 cm	Novo Horizonte. Ibitiara. Bahia/Brazil
Aegirine. "Acmite"	$\text{NaFe}^{3+}[\text{Si}_2\text{O}_6]$	4.5 x 2.5 cm	Rundemyr. Øvre Eiker. Buskerud. Norway/TYP
Fluorapatite. Albite	$\text{Ca}_5(\text{PO}_4)_3\text{F}, \text{NaAlSi}_3\text{O}_8$	1.2 x 0.5 cm	Golconda Mine. Governador Valadares. Doce Valley. Minas Gerais/Brazil

40 **Tab. S2: Rare Earth Oxide Powders, Suppliers, Product Number and Lot Number. Certificates of purity can be found in the data description** (Koerting et al., 2019a).

Rare Earth Oxide Powder, Supplier	Product Number	Lot Number
Lanthanum (III) oxide, REacton	11272	B08X015
Cerium (IV) oxide, REacton	11372	L07S057
Neodymium (III) oxide, REacton	11250	C02W029
Samarium (III) oxide, REacton	11229	61200836
Europium (III) oxide, REacton	11299	A16Z001
Gadolinium (III) oxide, REacton	11290	A13W016
Terbium (III,IV) oxide, REacton	11208	J24Q019
Dysprosium (III) oxide, REacton	11319	61300733
Holmium (III) oxide, REacton	11280	J11X030
Erbium (III) oxide, REacton	11310	61000356
Thulium (III) oxide, REacton	11198	F25S060
Ytterbium (III) oxide, REacton	11191	61201069
Lutetium (III) oxide, REacton	11255	G14X082
Yttrium (III) oxide, Sigma-Aldrich	204927	MKBL2030V
Niobium (V) oxide, Alfa Aesar	11366	L18Y022
Tantalum (V) oxide, Alfa Aesar	14709	I14Y039





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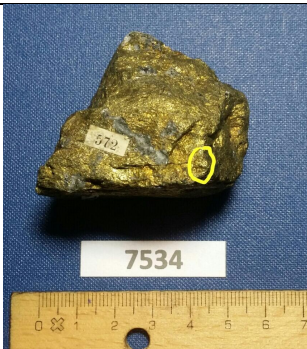
Tab. S3: Copper minerals, Abbreviation, alteration, collection, collection locality (Koellner et al., 2019).




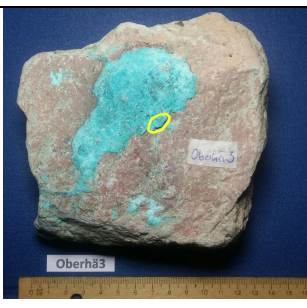
sample	alteration	collection	Collection locality
K1	slightly altered	University of Potsdam	Furnace, Luebeck, Germany
A1	altered, nodular	University of Potsdam	Cheroy near Lyon, France
A2	altered	University of Potsdam	Tsumeb near Otavi, Namibia
A3	strongly altered	BGR Spandau	Cornberg near Fulda, Germany
M1	altered, nodular	BGR Spandau	L'Etoile du Congo Mine, Katanga, Kongo
M2	strongly altered	BGR Spandau	Henderson Mine, Clear Creek Country, USA
M3	altered	BGR Spandau	Tsumeb near Otavi, Namibia
M4	strongly altered	BGR Spandau	Ogonja Mine in Okahandja, Namibia
M5	lightly altered, spicular	BGR Spandau	Siegen, Germany
C1	strongly altered	BGR Spandau	Füsseberg Mine, Siegerland, Germany
C2	slightly altered	BGR Spandau	Erzgebirge, Slovakia
C3	tarnished	BGR Spandau	Henderson Mine, Clear Creek Country, USA
C4	slightly altered	University of Potsdam	Cornwall, England, GB
C5	altered	University of Potsdam	Clausthal, Harz, Germany
P1	slightly altered	University of Potsdam	Jordan
P2	slightly altered	University of Potsdam	Jordan
P3	slightly altered	University of Potsdam	Jordan
B1	slightly altered, powdered	BGR Spandau	Altenberg, Slovakia
F1	slightly altered	BGR Spandau	Kotterbach near Witkow, Poland
L1	slightly altered, spicular	Uni Potsdam	Unknown location




Tab. S4: Copper bearing minerals listed with their sample name and collection (University of Potsdam = UP, BGR Spandau = BGR) and the area of sampling for EDX/WDX analyses and spectra retrieval (Koellner et al., 2019).

Sample	Sample name (collection)	Material	Formula	Spectra and sampling location
K1	600-1 (UP)	Copper	Cu	
A1	2458 (UP)	Azurite	$\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$	
A2	2437 (UP)	Azurite	$\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$	
A3	S101L7 (BGR)	Azurite	$\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$	

M1	S134R8 (BGR)	Malachite	$\text{Cu}_2[(\text{OH})_2\text{CO}_3]$	 A bright green, crystalline malachite specimen with a rough, irregular shape. A small yellow circle highlights a specific area on the surface. A ruler is visible at the bottom for scale. The label 'S134R8' is printed on a white tag at the bottom of the specimen.
M2	S131L5 M (BGR)	Malachite	$\text{Cu}_2[(\text{OH})_2\text{CO}_3]$	 A malachite specimen with a mix of green and brownish-orange colors, showing a more complex, layered structure. A small yellow circle highlights a specific area. A ruler is visible at the bottom. The label 'S131L5 M' is printed on a white tag at the bottom.
M3	S131R4 (BGR)	Malachite	$\text{Cu}_2[(\text{OH})_2\text{CO}_3]$	 A malachite specimen with a mix of green and brownish-orange colors, showing a more complex, layered structure. A small yellow circle highlights a specific area. A ruler is visible at the bottom. The label 'S131R4' is printed on a white tag at the bottom.
M4	S132L2 (BGR)	Malachite	$\text{Cu}_2[(\text{OH})_2\text{CO}_3]$	 A bright green, crystalline malachite specimen with a rough, irregular shape. A small yellow circle highlights a specific area on the surface. A ruler is visible at the bottom. The label 'S132L2' is printed on a white tag at the bottom.
M5	S55L16 M (BGR)	Malachite	$\text{Cu}_2[(\text{OH})_2\text{CO}_3]$	 A malachite specimen with a mix of green and brownish-orange colors, showing a more complex, layered structure. A small yellow circle highlights a specific area. A ruler is visible at the bottom. The label 'S55L16 M' is printed on a white tag at the bottom.

C1	S55L16 C (BGR)	Chalcopyrite	CuFeS ₂	
C2	S115R12 (BGR)	Chalcopyrite	CuFeS ₂	
C3	S131L5 C (BGR)	Chalcopyrite	CuFeS ₂	
C4	7534 (UP)	Chalcopyrite	CuFeS ₂	

C5	7526 (UP)	Chalcopyrite	CuFeS_2	
P1	Oberhä (UP)	Plancheite	$\text{Cu}_8\text{Si}_8\text{O}_{22}(\text{OH})_4 \cdot \text{H}_2\text{O}$	
P2	Oberhä2 (UP)	Plancheite	$\text{Cu}_8\text{Si}_8\text{O}_{22}(\text{OH})_4 \cdot \text{H}_2\text{O}$	
P3	Oberhä3 (UP)	Plancheite	$\text{Cu}_8\text{Si}_8\text{O}_{22}(\text{OH})_4 \cdot \text{H}_2\text{O}$	






B1	S115R3 (BGR)	Brochantite	$\text{Cu}_4(\text{SO}_4)(\text{OH})_6$	
F1	S115R14 (BGR)	?	?	
L1	9542 (UP)	Linarite	$\text{PbCu}(\text{SO}_4)(\text{OH})_2$	







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Table S5: Apliki mine samples, including description, coordinates of sampling in March 2018 in the Republic of Cyprus and a field photo of the sample (Koerting et al., 2019b).



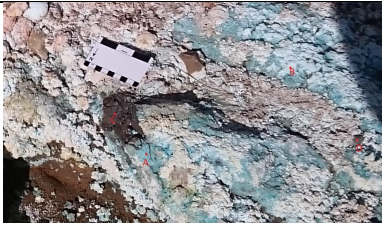
sample	description	decimal latitude	decimal longitude	photo
<i>AplI_A_1a</i>	<i>"fresh" surface</i>	35.077033	32.842833	
<i>AplI_A_1b</i>	<i>hematite coloured</i>	35.077017	32.842833	
<i>AplI_A_1d</i>	<i>"fresh" dark green</i>	35.077017	32.842833	
<i>AplI_A_1e</i>	<i>yellowish-orange weathered</i>	35.077033	32.8428	
<i>AplI_A_1f</i>	<i>"soil formation", gravel</i>	35.07700	32.84275	

<i>Apl1_A_2a</i>	<i>waste, soil</i>	35.076867	32.84275	
<i>Apl1_A_3a</i>	<i>yellowish weathered, soil</i>	35.076983	32.843083	
<i>Apl1_A_3b</i>	<i>brownish weathered, soil</i>	35.077	32.84305	
<i>Apl1_A_4a</i>	<i>white, soil-ish</i>	35.076967	32.843067	
<i>Apl1_A_4b</i>	<i>grey, soil-ish</i>	35.077	32.843033	
<i>Apl1_A_4c</i>	<i>grey-green</i>	35.077	32.842633	

Apl1_A_5a	<i>grey-medium</i>	35.076983	32.843167	
Apl1_A_5b	<i>grey-dark</i>	35.07705	32.843167	
Apl1_A_5c	<i>grey-light</i>	35.077083	32.843183	
Apl1_A_6a	<i>soil, gravel</i>	35.076967	32.8431	
Apl1_A_6b	<i>soil, gravel</i>	35.07695	32.8432	All samples from same spot, see 6a
Apl1_A_6c	<i>soil, gravel</i>	not available	not available	All samples from same spot, see 6a
Apl1_A_6d	<i>soil, gravel</i>	not available	not available	All samples from same spot, see 6a
Apl1_A_7d	<i>Grey, crust unstable</i>	35.076967	32.84325	

Apl1_A_7d_Hem	<i>Red, hematite</i>	35.076967	32.84325	
Apl1_A_7e	<i>blue crystals</i>	35.076833	32.843217	
Apl1_A_8a	<i>grey, soil-ish,</i>	35.076917	32.8433	
Apl1_A_8b	<i>grey, soil-ish,</i>	35.076933	32.84335	
Apl1_A_8c	<i>grey, soil-ish,</i>	35.076917	32.8433	
Apl1_A_9a	<i>light green</i>	35.076883	32.843333	

Apl1_A_9b	<i>hematite vein</i>	35.076833	32.843317	
Apl1_A_10a	<i>white with pink</i>	35.076733	32.843383	
Apl1_A_10b	<i>white with purple</i>	35.076833	32.843383	
Apl1_A_10c	<i>greenish veins</i>	35.07685	32.843333	
Apl1_A_10d	<i>white</i>	35.076833	32.84335	See overview photo from 10c, no detail photo available
Apl1_A_11a	<i>weathering crust</i>	35.076783	32.843533	
Apl1_A_11b	<i>green</i>	35.076767	32.843517	

Apl1_A_13a	<i>red, rock</i>	35.076133	32.843333	
Apl1_A_13b	<i>red, gravel, weathered hillside rock</i>	35.076117	32.8434	
Apl1_A_15a	<i>dark blue</i>	35.076133	32.843217	
Apl1_A_15b	<i>light blue rock+ blue crust</i>	35.076133	32.843217	See sample Apl1_A_15a
Apl1_A_15c	<i>black pyrite</i>	35.076133	32.843217	See sample Apl1_A_15a

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12. References

Bösche, N. K.: Detection of Rare Earth Elements and Rare Earth Oxides with Hyperspectral Spectroscopy, University of Potsdam. [online] Available from: <http://nbn-resolving.de/urn:nbn:de:kobv:517-opus4-85363>, , Dissertation University
80 Potsdam.. 2015.

Herrmann, S.: Capacity of imaging spectroscopy for the characterisation of REO, REE bearing minerals and primary REE-deposits, Scientific Technical Report - Data ; 19/08, <http://doi.org/10.2312/GFZ.B103-19089>, 2019.

Koellner, N., Koerting, F., Horning, M., Mielke, C. and Altenberger, U.: Mineral spectra and chemistry of 20 copper bearing minerals., [https://doi.org/ http://doi.org/10.5880/GFZ.1.4.2019.003](https://doi.org/http://doi.org/10.5880/GFZ.1.4.2019.003), 2019

Koerting, F., Herrmann, S., Boesche, N. K., Mielke, C., Koellner, N. and Altenberger, U.: Mineral spectra and chemistry of
90 32 rare-earth minerals and rare-earth oxides including., [http://doi.org/ http://doi.org/10.5880/GFZ.1.4.2019.004](http://doi.org/http://doi.org/10.5880/GFZ.1.4.2019.004), 2019a.

Koerting, F., Rogass, C., Koellner, N., Horning, M. and Altenberger, U.: Mineral spectra and chemistry of 37 copper bearing surface samples from Apliki copper-gold-pyrite mine in the Republic of Cyprus., [https://doi.org/ http://doi.org/10.5880/GFZ.1.4.2019.005](https://doi.org/http://doi.org/10.5880/GFZ.1.4.2019.005), 2019b.