



Antimony – From Active Volcanoes to Old Shields

Metallogenesis, Ore Deposits, Mineralogy

B1.2 Ulrich Schwarz-Schampera

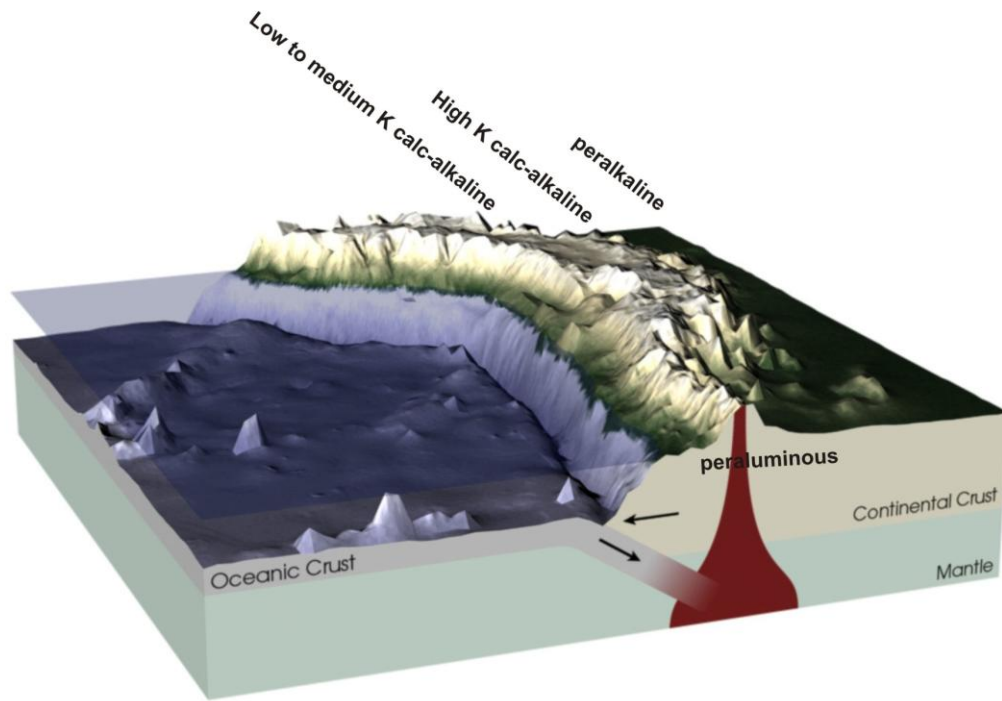


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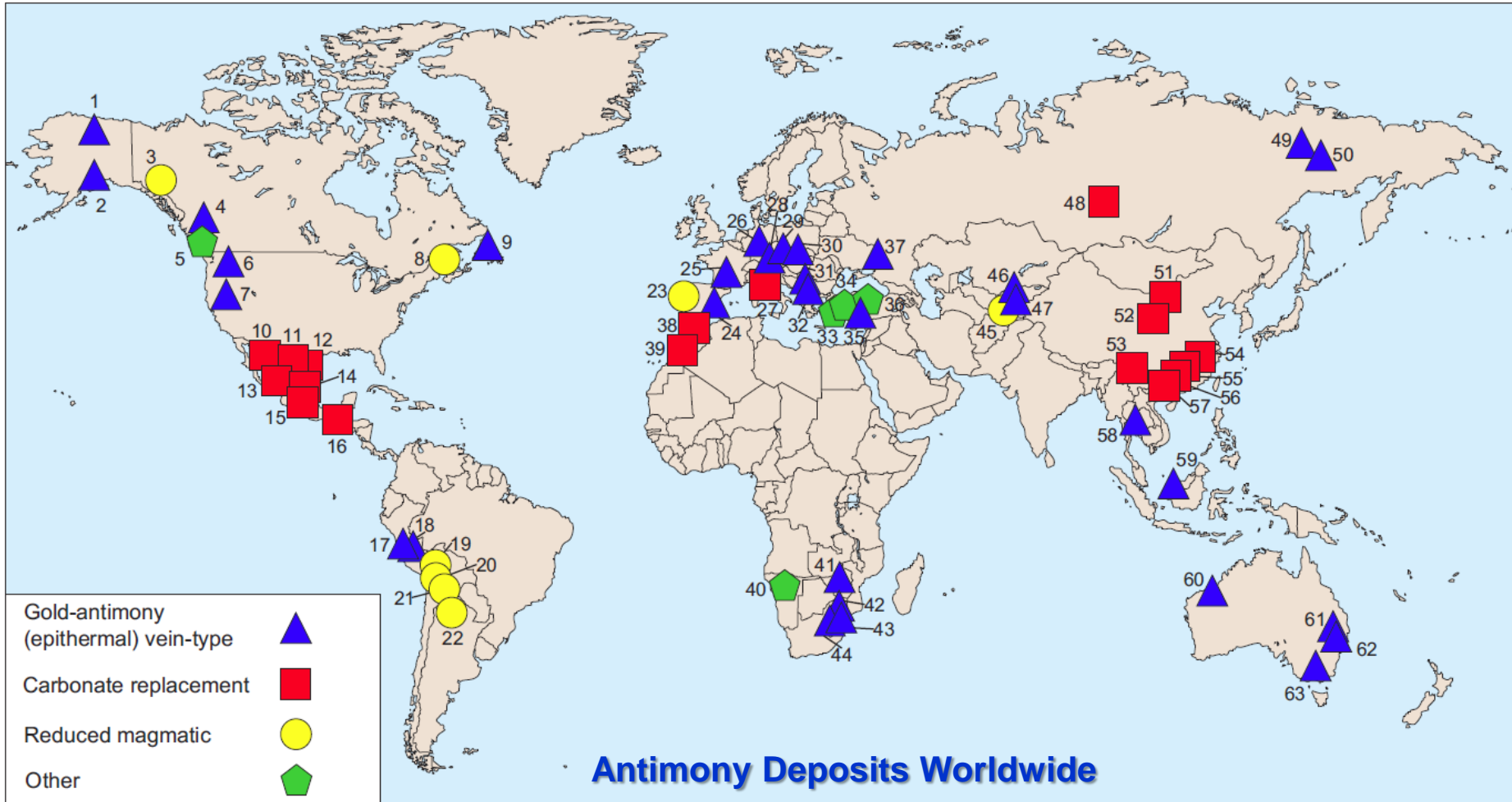
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Antimony Abundance in the Earth








- Earth's crust : 0.2 ppm in the continental crust (\leq As, Tl);
- Concentrations in oceanic basalts: 0.02 - 0.8 ppm Sb;
- Moderately siderophile element, moderately incompatible and lithophile (such as the light rare earth elements) during magmatic processes;
- The volatile behaviour during subduction processes and crust formation, similar to Pb;
- The meteoritic abundance 0.142 ppm for chondrite (CI);
- Seawater contains 0.15 ppb Sb;
- Geochemically related to Hg, As;
- In ore-forming processes highly volatile, chalcophile in character;
- An **enrichment** of about **150,000 times** its **crustal content** is required to reach potentially economic concentrations of about three weight per cent (**3 wt.-%**), or 30 kg of antimony per tonne of antimony ore.

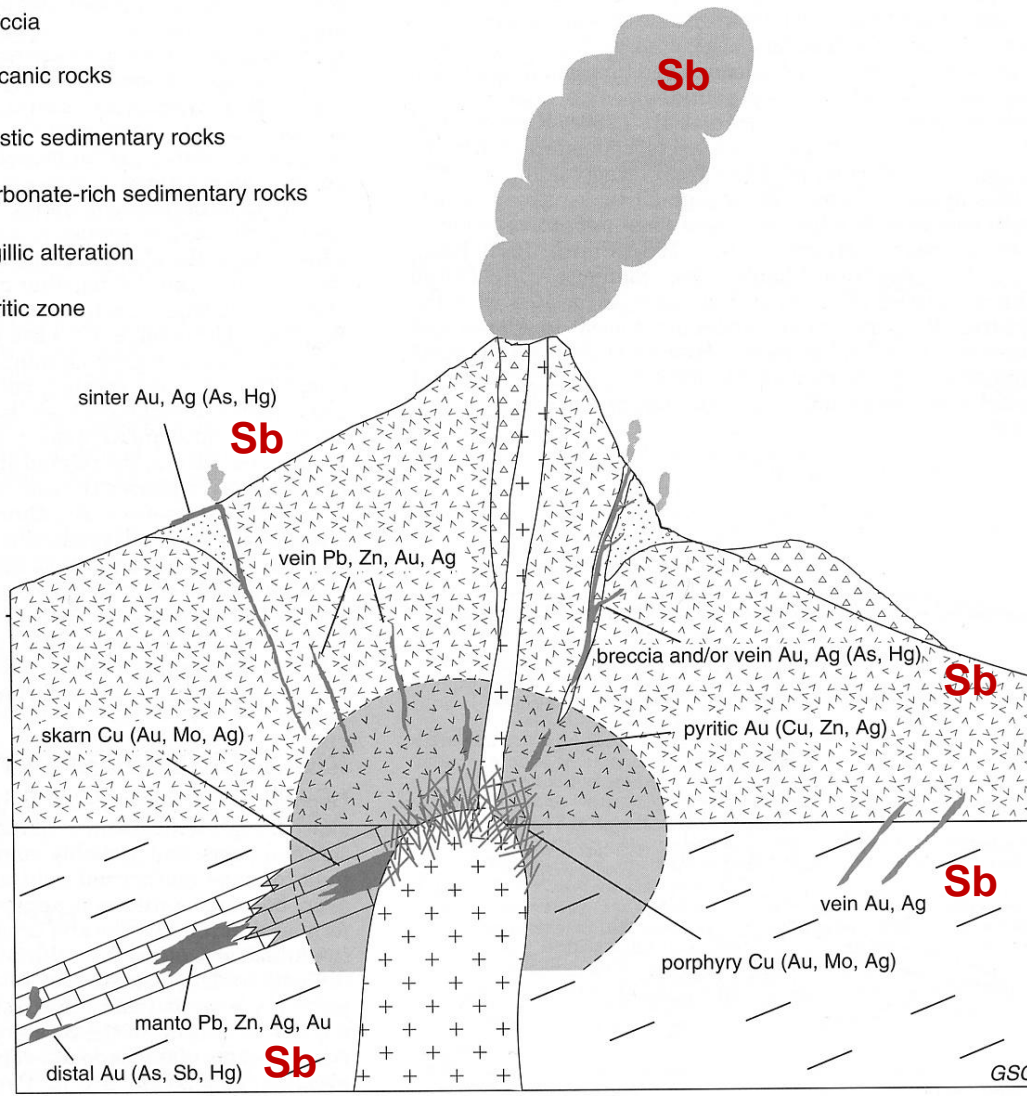


- Active continental plate margins;
- Prominent antimony belts (China, South America, Europe)
- Highest concentrations commonly in low-temperature magmatic hydrothermal systems;
- Typically enriched in the distal portions of these systems at shallow depths and close to surface;
- Associated with calc-alkaline to peralkaline, porphyritic felsic to intermediate volcanic and intrusive wall rocks.



1 Workman's Bench, Nolan Creek	14 San Luis Potosi district	27 Manciano area	40 Tsumeb	52 Quinling-Kunlunshan belt (>50 deposits)
2 Eagle Creek	15 Queretaro district	28 Schlaining, Burgenland	41 Kwekwe district	53 Western Yunnan Tibet belt (10 deposits)
3 Becker-Cochran	16 Ixtahuacan (3 deposits)	29 Krasna Hora, Bohemia	42 Consolidated Murchison	54 South China belt (500 deposits)
4 Morris	17 Minera Halcon de Gorgor	30 Slovakia (2 deposits)	43 Moming Mist, Barberton	55 South China belt (500 deposits)
5 Sullivan	18 Cobriza, La Oroya	31 Kostajnik-Krupanj district	44 Msauli, Barberton	56 South China belt (500 deposits)
6 Coeur d'Alene district	19 Lipichi district (>10 deposits)	32 Allchar (Alsar) district	45 Tajikistan (3 deposits)	57 South China belt (500 deposits)
7 Fencemaker	20 San Jose, Oruro district	33 Izmir Province	46 Kassan / Chauvay	58 Thailand (5 deposits)
8 Belledune/Lake George	21 Potosi department (>20 deposits)	34 Kütahya Province	47 Kadamzhay / Khaidarkan	59 Bau district, Sarawak
9 Beaver Brook	22 Pabellon	35 Nigde Province	48 Olimpiada	60 Blue Spec, Western Australia
10 Sonora district	23 Alto do Sobrido	36 Tokat Province	49 Sentachan	61 Hillgrove, New South Wales
11 Coahuila district	24 San Antonio	37 Nikitovaka	50 Sarylakh	62 New South Wales (3 deposits)
12 Nuevo Leon district	25 Montagne Noi	38 Beni-Msala	51 Changbaishan-Yinshan-Tianshan belt (10 deposits)	63 Costerfield, Victoria
13 Zacatecas district	26 Germany (3 deposits)	39 Tourtit		

-  Porphyry intrusion
-  Breccia
-  Volcanic rocks
-  Clastic sedimentary rocks
-  Carbonate-rich sedimentary rocks
-  Argillic alteration
-  Pyritic zone



Antimony Deposit Types



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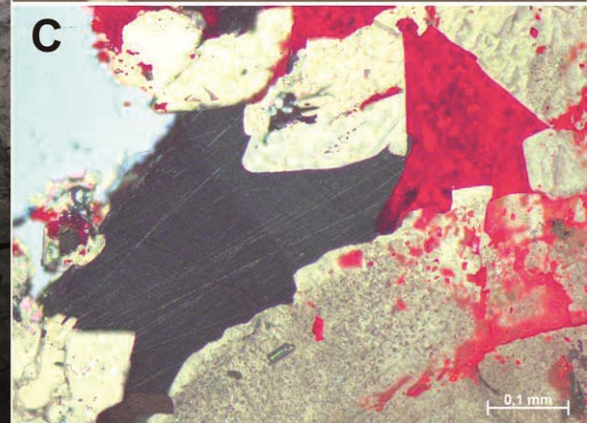
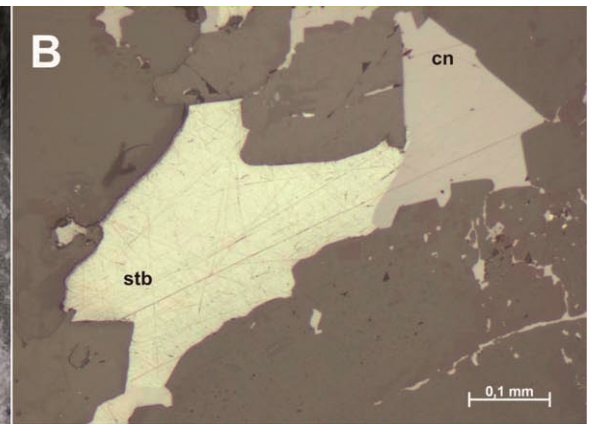


Table 3 Size and grade of the major types of antimony deposits (grades and tonnages are very variable between deposits and figures given are indicative only).

Deposit type	Deposit size range (metric tonnes)	Typical grade (Sb ₂ S ₃ %)	Estimated antimony metal content of known deposits (tonnes)	% of total
Gold-antimony (epithermal) vein-type	10 ⁴ –10 ⁶	0.1–3.5	580 000	20
Carbonate replacement	10 ⁶ –10 ⁸	1.5–25	2 500 000	60
Reduced-magmatic	10 ⁶ –10 ⁸	0.1–1.5	320 000	10
Polymetallic base metal vein	10 ⁴ –10 ⁶	0.1–0.5	175 000	8
Hot springs	10 ⁴ –10 ⁶	0.1–0.2	2 500	2
			3 577 500	100



Antimony Deposit Types



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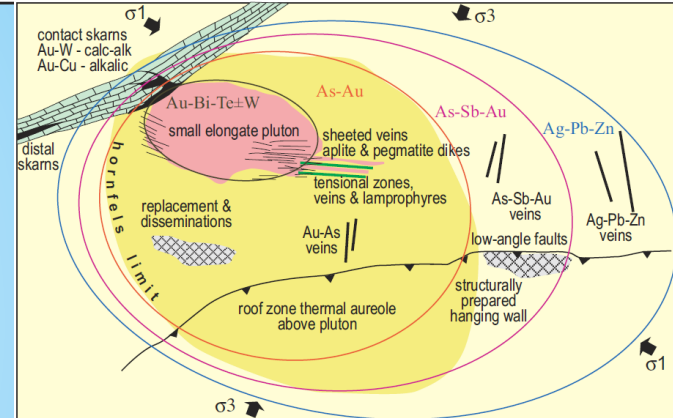
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Deposit type	Brief description	Features	Examples
Gold-Antimony (Epithermal) Vein-Type	Medium to large, low-grade stockwork-type quartz-stibnite (tetrahedrite) veinlets and disseminations in shale, calcareous shale, limestone, quartzite, volcanic, granite (or metamorphic equivalents) in greenstone belts of a potential subduction zone and island arc setting .	Deposits lack significant copper, lead, zinc, and nickel sulphide and sulfosalt minerals; Sb-As-Hg-Au-Ag-Te assemblage of the high low-sulfidation subtype in epithermal environments; veins of quartz cored by massive stibnite; wall rock equilibration of magmatic fluids; transitions to mesozonal (orogenic) deposits.	Hemlo (Canada), Olimpiada (Russia),



Deposit type	Brief description	Features	Examples
Greenstone-hosted quartz-carbonate vein and carbonate replacement	Numerous small to large size, high-grade vein-stockwork deposits of almost pure stibnite in metasedimentary and highly altered volcanic sequences. Syn- to post-collisional tectonic settings.	Deposits may lack significant base or precious metal assemblages; lenticular bodies of quartz and stibnite within limestone and intense quartz-carbonate alteration; silicification	Xikuangshan (China), Kadamdzhay (Russia), Antimony line (South Africa), Olympiada (Russia), Indarama Mine, Belingwe Star (Zimbabwe)



Deposit type	Brief description	Features	Examples
Reduced-Magmatic	Regional arrays of sheeted auriferous quartz-carbonate veins in the carapace and volcanic surroundings of causative plutons ; small to intermediate size proximal As-Sb-Au veinlets . Weak post-collisional extension behind a thickened continental margin.	Deposits occur in a mineral system with an outward zonation of an Au-Bi-Te-W-As-Sb-Ag-Pb-Zn assemblage ; skarn-like and replacement bodies and veins; associated with volatile-rich quartz monzonite melts.	Tintina Au province (USA, Canada), Timbarra, Kidston, (Australia), Niuxinshan (China)



Deposit type	Brief description	Features	Examples
Polymetallic Base Metal Vein	Small to medium polymetallic deposits; structurally controlled in postcollisional vein breccia zones of clastic metasedimentary or magmatic-dominated terranes; mineralization by basinal brines.	Polymetallic base metal and Ag-rich ores; densely intergrown ore minerals (telescoping); Sb hosted by stibnite, tetrahedrite and a variety of simple and complex sulphosalts; quartz-carbonate gangue.	Cobalt district (Canada), Bolivian Sb belt, Bau district (Malaysia)



Deposit type	Brief description	Features	Examples
Hot spring exhalative	Siliceous precipitates deposited by hydrothermal fluids, hot springs, fumaroles; volcanic activity	Low temperature fluids forming sulphide and sulphosalt segregations in altered intermediate to felsic wall rocks; Sb co-enrichment with As and Hg (Te, Se, Au, Ag)	Shallow marine hydrothermal vents and magmatic fumaroles at Kudryavyi, Kuril islands (Russia), Merapi (Indonesia), Taupo volcanic zone (NZ)

Table 2 Compilation of defined antimony minerals with antimony concentrations greater than 70% Sb and additional antimony minerals which typically occur in antimony-bearing ore deposits.

Mineral	Formula	% Sb
Antimony	Sb	100.00
Senarmontite	Sb ₂ O ₃	88.39
Valentinite	Sb ₂ O ₃	83.53
Nisbite	NiSb ₂	80.58
Onoratoite	Sb ₈ O ₁₁ Cl ₂	79.78
Cervantite	Sb ³⁺ Sb ⁵⁺ O ₄	79.19
Stibiconite	Sb ³⁺ Sb ⁵⁺ O ₆ (OH)	76.37
Sarabauite	CaSb ₁₀ O ₁₀ S ₆	75.62
Kermesite	Sb ₂ S ₂ O	75.24
Coquandite	Sb ₆ O ₈ (SO ₄)·(H ₂ O)	75.11
Stibnite	Sb₂S₃	71.68
Breithauptite	NiSb	67.47
Stibarsen	SbAs	61.91
Gudmundite	FeSbS	58.07
Ullmannite	NiSbS	57.29
Berthierite	FeSb ₂ S ₄	56.94
Aurostibite	AuSb ₂	55.28
Chalcostibite	CuSbS ₂	48.81
Jamesonite	Pb ₄ FeSb ₆ S ₁₄	35.39
Tetrahedrite	(Cu,Fe) ₁₂ Sb ₄ S ₁₃	29.64
Famatinite	Cu ₃ SbS ₄	27.63
Dyscrasite	Ag ₃ Sb	27.34
Boulangerite	Pb ₅ Sb ₄ S ₁₁	26.44
Bournonite	PbCuSbS ₃	24.91
Pyrargyrite	Ag ₃ SbS ₃	22.48
Freibergite	(Ag,Cu,Fe) ₁₂ (Sb,As) ₄ S ₁₃	18.93
Vinciennite	Cu ₁₀ Fe ₄ Sn(As,Sb)S ₁₆	3.83

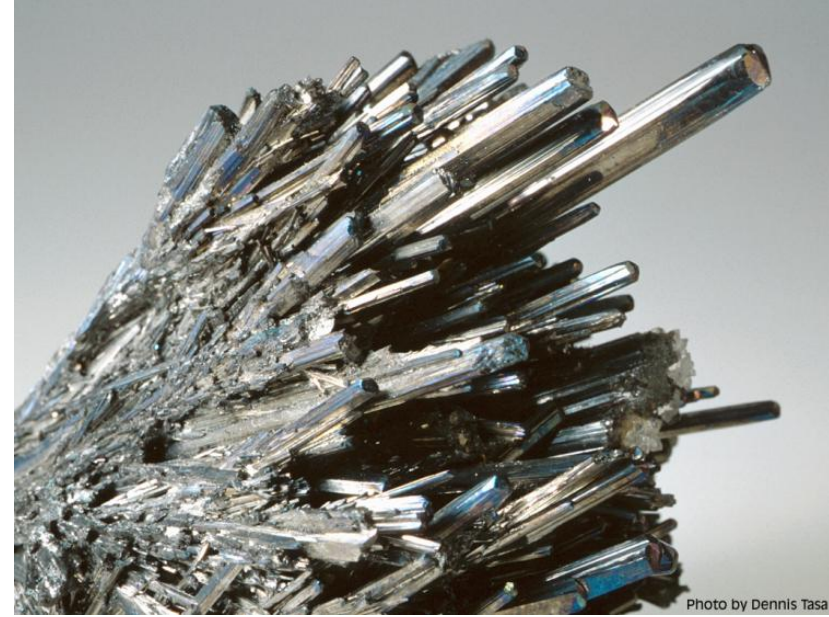
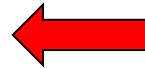


Photo by Dennis Tasa



Mineralogy (≥ 264 minerals)



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Thank you very much for your attention !

Questions ?