SVERIGES GEOLOGISKA UNDERSÖKNING

SER. Ca. AVHANDLINGAR OCH UPPSATSER I 4:o NR 46

H. HÜBNER

MOLYBDENUM AND TUNGSTEN OCCURRENCES IN SWEDEN

SAMMANFATTNING: MOLYBDEN- OCH VOLFRAMFÖREKOMSTER I SVERIGE

With 12 plates

STOCKHOLM 1971

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ABSTRACT

The alloy-metals molybdenum and tungsten, both discovered by C. W. Scheele, are of growing importance for high-temperature application, stainless steel, and powder metallurgy.

In Sweden most of the molybdenum and tungsten occurrences are of *contact-metasomatic* character and have to be placed within the pegmatitic to pneumatolytic P-T range. They are mainly situated in the central part of the country and seem essentially to be connected with Late Svecofennian sialic-palingenic magmatism. This group covers the occurrences of "Yxsjö-Hörken type" (defined by Magnusson, 1940).

Other *pegmatitic-pneumatolytic* deposits worth mentioning are Baggetorp (with wolframite as the main ore mineral) and Iggöhällan (molybdenite). Uddgruvan, which has contributed more than half of the total MoS_2 production in Sweden, belongs to the *pegmatitic* group.

Pneumatolytic to hydrothermal Mo and W occurrences are chiefly to be found in the Skellefte and Arvidsjaur District, Västerbotten county (Grip 1951).

Mineralizations in *granitoid rocks* are of subordinate importance. Mo and W contained in Paleozoic *black shales* have at present no economic significance.

All molybdenum deposits are of small size. Some of them have been worked during periods of extreme demand, as during and shortly after the World Wars, but none are presently being exploited. The only commercially significant tungsten occurrence has been worked spasmodically in the Yxsjö Mines, which are scheduled to be brought into production again in 1971. The total MoS_2 production originating from Swedish deposits does not exceed 200 tons; the W-content of concentrate obtained from scheelite and wolframite ores mined hitherto is estimated at about 5 600 tons.

An outline is given on such matters as world production, consumption, price, and the uses of molybdenum and tungsten. In an Appendix may be found essential data of about 150 properties. To complete the over-all picture geological data, especially concerning Northern Sweden, have been selected from earlier reports. The location and stage of development of Mo and W occurrences in Central Sweden are shown on accompanying maps.

SAMMANFATTNING

Molybden- och volframförekomster i Sverige

Legeringsmetallerna molybden och volfram, båda upptäckta av C. W. Scheele, är av växande betydelse för högtemperaturtekniken, rostfritt stål och pulvermetallurgin.

De flesta svenska molybden- och volframförekomsterna är av *kontakt-metasomatisk* typ och faller inom det pegmatitiska till pneumatolytiska tryck-temperaturområdet. Dessa fyndigheter ligger huvudsakligen i Mellansverige och synes väsentligen stå i sammanhang med sensvekofenniska, sialisk-palingena magmatiska processer. Denna grupp täcker de mineraliseringar, som Magnusson (1940) kallat "Yxsjö-Hörkentypen".

Andra nämnvärda fyndigheter av *pegmatitisk-pneumatolytisk* karaktär är Baggetorp (med volframit som viktigaste malmmineral) och Iggöhällan (molybdenglans). Uddgruvan, som stått för mer än hälften av Sveriges totala MoS_2-produktion, är av *pegmatitisk* typ.

Pneumatolytiska till hydrotermala molybden- och volframförekomster finner man i huvudsak inom Skellefte- och Arvidsjaurfälten (Grip 1951).

Mineraliseringar i *granit-massiv* är av underordnad betydelse. De paleozoiska *alunskiffrarnas* molybden- och volframhalter är f. n. utan ekonomiskt värde.

Alla kända molybdenförekomster är små. Några av dem har bearbetats under och kort tid efter de båda världskrigen, när tillgången på legeringsmetaller var begränsad. Ingen molybdenfyndighet är i produktion. De enda volframmalmerna av betydelse ligger inom Yxsjöfältet, vars gruvor f. n. är nedlagda. Driften skall dock planenligt återupptas i statlig regi år 1971. Den totala molybdenproduktionen från svenska förekomster uppskattas till ungefär 200 ton MoS_2, och W-innehållet i slig från hittills brutna scheelit- och volframit-anrikningsmalmer till ca 5 600 ton.

Denna publikation innehåller också en kort sammanställning betr. världsproduktionen, förbrukningen, priserna och tillämpningsområdena för både molybden och volfram. Väsentliga uppgifter rörande 150 fyndpunkter har sammanfattats i tabellform. För att komplettera helhetsbilden har geologiska data, särskilt beträffande mineraliseringar i norra Sverige, tagits ur redan existerande specialbeskrivningar. Läget och utvecklingsstadiet av Mo- och W-förekomsterna i Mellansverige framgår av de bifogade kartorna.

FOREWORD

During the summer of 1965 the writer had the opportunity to visit most of the molybdenum and tungsten occurrences in Central and Southern Sweden. An inventory has been made on behalf of the Geoscience Department of the AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH. In order to provide an over-all picture essential data about molybdenum and tungsten mineralization, especially concerning Northern Sweden, have been selected from geological literature. The present Report was prepared in 1969–1970 during a UN assignment in Iran.

The purpose of this paper is to provide all available information which may serve as a basis for future prospecting.

Teheran, May 1970

1. PREVIOUS WORK AND ACKNOWLEDGEMENTS

In an outstanding symposium of the non-ferrous resources of Sweden Tegengren (1924) presented all information then available on Mo and W mineralization. The occurrences of the Ljusnarsberg ore province, Central Sweden, have been described in detail by Magnusson (1940). E. Grip has investigated the sulphide deposits in Västerbotten with regard to tungsten and molybdenum; his comprehensive study was published in 1951. The mineralizations in Norrbotten have been described *inter alia* by Högbom (1931) and Ödman (1943, 1947, 1950, and 1957). The work of other writers on individual occurrences is given in the Appendix (Plates I–VIII). Rechenberg (1960), Ahlfeld (1958), and K. C. Li & Chung Yu Wang (1955) dealt respectively with molybdenum and tungsten in a world setting. An excellent review of molybdenum was, *inter alia*, presented by F. M. Vokes (1963) in his detailed report on the molybdenum deposits of Canada.

Firstly the writer wishes to express his gratitude to Mr. Axel Ax:son Johnson, who has generously given permission to publish the results of field investigations. He refers with deep appreciation to his former colleague Mr. S. Åsberg who accompanied him on nearly all field trips and whose profound geological knowledge was a great asset. He is indebted to Mr. A. Holmquist, AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH, for his constant co-operation and for having supplied him with literature during his stay in Iran. Mr. A. Kåre, head of the Library for Mathematics and Natural Science at STOCKHOLM UNIVERSITY, who has shown him many interesting occurrences in Central Sweden, was kind enough to contribute material.

The writer also thanks Mr. K. A. Lindbergson, general manager, and Drs. G. Kautsky and P. H. Lundegårdh, chiefs of the Mineral Resources Dept. and Geological Dept. respectively, GEOLOGICAL SURVEY OF SWEDEN, who have given encouragement to this publication.

He is also indebted to Professor G. J. Williams who kindly has revised the text, and to Drs. E. Grip and U. Svensson for discussing various geological problems.

Finally he thanks all his colleagues in the GEOLOGICAL SURVEY OF IRAN for helping him to prepare the manuscript and the plates.

2. CHEMICAL PROPERTIES AND GEOCHEMICAL CYCLE OF MOLYBDENUM AND TUNGSTEN

Molybdenum is a silvery white metal of the chromium group. Seven naturally occurring isotopes are known (92, 94, 95, 96, 97, 98, and 100). The metal is very hard and tough, having a specific gravity of 10.2. It was discovered in 1778 by Scheele, a celebrated Swedish chemist, who found that molybdenite on treatment with nitric acid produced "molybdic acid".He also concluded that molybdenite is a molybdenum sulphide. In 1782 the metal (melting point 2 600°C) itself was isolated by Hjelm.

Unlike tungsten, molybdenum is of siderophile-chalcophile character. It does not occur free in nature and is one of the scarcer components of the earth's crust.

Content of molybdenum in various rock types

Rocks of earth's crust, average (Sandell & Kurora 1954)	1±0.5 ppm
Igneous rocks (Sandell & Goldich 1943)	2.5 ppm
Granitic rocks, average of 135 samples (Sandell & Kuroda 1954)	1.1 ppm
Silicic rocks, average (Sandell & Goldich 1943)	2.5 ppm
Subsilicic rocks, average (Sandell & Goldich 1943)	2.0 ppm
Gabbros, average of 21 samples (Sandell & Kuroda 1954)	0.6 ppm
Basalts and diabases, average of 37 samples (Sandell & Kuroda 1954)	1.0 ppm
Ultramafic rocks, average of 23 samples including 9 serpentinites (Sandell & Kuroda 1954)	0.4 ppm
Deep sea sediments (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	3–42 ppm
Shales (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	0.7–1.1 ppm

Alum shale, Central Sweden	80–330 ppm
"Kupferschiefer", Mansfeld, Germany	100–200 ppm
Shungite and shungite schists, Eeastern Fennoscandia (Rankama & Sahama 1960)	up to 40 ppm
Sandstones (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	0.4–0.8 ppm
Carbonate rocks (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	0.4–1.0 ppm
Metam. rocks (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	0.6 ppm

Kreiter (1968, p. 154) has recently published analyses of various intrusive rocks belonging to the Megri plutones, Sovyet Armenia:

	ppm Mo	ppm Cu	Mo/Cu
Intrusive: 1st stage: gabbro, gabbro-diorite (3 samples)	2.5	150	0.017
Intrusive, 1st stage: monzonite, syenite, diorite (8 samples)	5.4	96	0.056
Intrusive, 2nd stage: granodiorite-syenite (8 samples)	5.3	53	0.100
Intrusive, 3rd stage: porphyritic granite (12 samples)	6.2	52	0.119
Average of plutonic body (41 samples)	5.2	72	0.072
Barren granitoid rocks (30 samples)	1.8±0.4	40±11	0.045
Average of granitoid rocks (according to Vinogradov)	1.9	30	0.063

Dr. Uno Svensson, BOLIDEN AB, selected a series of samples of Archean rocks from Västerbotten, Northern Sweden. 123 samples of phyllites, 170 samples of gneisses and 153 samples of Revsund granite were analysed for molybdenum (limit of sensitivity 2 ppm). 8 percent of the gneiss samples showed values exceeding 2 ppm and 3 percent exceeding 7 ppm Mo. 25 percent of the phyllite samples held more than 2 ppm, and 2 percent more than 18 ppm Mo. Practically all analyses of Revsund granite showed molybdenum contents below 2 ppm.

Generally speaking, acidic rocks seem to be richer in molybdenum than basic and ultrabasic rocks. During the process of magmatic crystallization molybdenum, favouring rocks of alkalic character, shows a tendency to be concentrated in the late differentiates. Molybdenum has a proven affinity for sulphur, and is frequently accompanied by copper, as for example in many "porphyry copper" deposits.

The two most important ore minerals are molybdenite and wulfenite. The occurrences of world-wide economic significance are of pneumatolytic to hydrothermal type.

Tungsten, which in Swedish means "heavy stone", has five naturally occurring isotopes (180, 182, 183, 184, and 186) and its specific gravity is 19.2. It exhibits valencies of from two to six, but its most stable derivatives are those containing hexavalent tungsten. This metal also was discovered by Scheele in 1783 with the assistance of the Spanish brothers J. J. and F. de Elhuyar. Tungsten belongs chemically to the chromium group and has the highest melting point of any metal (3 380° C). Tungsten does not occur native and its compounds are rather rare. The most important ores are the scheelite group (calcium tungstates) and the wolframite group (iron and manganese tungstates).

Content of tungsten in various rock types

Igneous rocks (Sandell 1946)	1.5 ppm
Basic rocks, Central Roslagen, Sweden (Lundegårdh 1946)	10 ppm
Acidic rocks, Central Roslagen, Sweden (Lundegårdh 1946)	7 ppm
Silicic and intermediate igneous rocks (Sandell 1946)	1.5 ppm
Shale (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	1.8 ppm
Shungite and shungite schists, Eastern Fennoscandia (Rankama & Sahama 1960)	up to 80 ppm
Sandstone (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	1.6 ppm
Schists (Wilson & Fieldes 1944)	1–2 ppm
Metam rocks (Green, Table 2, Bull. Geol. Soc. Am., Vol. 70)	1–2 ppm

Kreiter (1968, p. 152) has presented the following values for rocks from the U.S.S.R.:

A. Granitoid rocks without tungsten mineralization

	ppm W
Ukraine (11 samples)	3.0±1.3
Caucasus (15 samples)	1.8±0.5
Central Kalba (32 samples)	1.5±0.2
Zabaikale (8 samples)	3.0±1.2

B. Granitoid rocks with tungsten mineralization

	ppm W
Leucocratic granite, Altai (11 samples)	3.3±1.5
Jurassic two-mica granite, Zabaikale (30 samples)	7.8±2.1
Granite with greisen, Soktuisk (32 samples)	23±7

Tungsten is a lithophile element. As does molybdenum, it shows a tendency to be concentrated in the late magmatic differentiates, and in consequence tungsten is generally more abundant in acidic rocks, especially granites, than in basic igneous rocks.

The chemical properties of molybdenum and tungsten are similar. As the radii of Mo^{4+} and W^{4+} are equal, the two elements can easily replace each other in the crystal lattice, although molybdenum and tungsten, closely related as they are in the Periodic System, nevertheless show rather different geochemical characters.

For instance the tungstates are more resistant to weathering than the molybdates. Under favourable conditions, particularly in arid regions, wolframite and scheelite may be concentrated by the processes of transport and sedimentation to form placer deposits: this is not the case with molybdenum minerals. Generally speaking, the mobility of molybdenum is higher than that of tungsten. In the aqueous phase molybdenum seems to be present as MoO_4^{--} ions and undissociated $MoO_2.SO_4$, and tungsten probably in the form of WO_4^{--} ions. Both can be transported in solution without being redeposited to any considerable extent in the zone of cementation (cf. Rankama & Sahama 1960, pp. 628–630, and Vokes 1963, pp. 16–18).

Molybdenum is precipitated in ordinary hydrolysate sediments, but both molybdenum and tungsten, in solution in river water, are readily precipitated by reducing sediments such as sapropelites. These muds, being rich in organic material, form black shales, and examples of this type of redeposition in Fennoscandia are the so-called alum shales and shungites.

3. MINERALOGY AND ORE DRESSING

3.1. Molybdenum Minerals

Ore mineral	Chem. formula	Metallic Content	Colour	Crystal System	Specific Gravity
Molybdenite	MoS_2	59.9 % Mo	Bluish-grey	Hexagonal	4.62–4.73
Wulfenite	$Pb\,Mo\,O_4$	26 % Mo	Yellow to red	Tetragonal	6.7–6.9
Ferrimolybdite (molybdite, molybdic ochre)	$Fe_2(Mo\,O_4)_3 \cdot 8\,H_2O$?		White to yellow	Orthorhombic	4.0–4.5
Powellite	$Ca(Mo,W)\,O_4$	W substitutes for Mo up to a ratio of Mo : W = 9:1	White, yellow, brown, greenish-blue	Tetragonal	4.3 ±
Ilsemannite (molybdenum blue)	$Mo_3O_8(+nH_2O+H_2SO_4)$		Blue to black	Earthy	

Commercially, practically all molybdenum is obtained from *molybdenite,* the only known primary molybdenum mineral. The crystal lattice is complicated and sheet-like.

The crystals are mainly tabular, or less commonly pyramidal or prismatic. Molybdenite often appears in the form of impregnations, preferably at the boundary between quartz veinlets and the adjacent rock. If the wall-rock is gneissose or schistose, the molybdenite flakes are normally parallel with the schistosity. Aggregates frequently show the effect of post-crystalline deformation (Fig. 9).

Molybdenite is a typical pegmatitic-pneumatolytic mineral, frequently found in contact-metasomatic deposits, and it also occurs as an accessory in certain granites. In hydrothermal associations it indicates high temperature. Molybdenite usually contains traces of rhenium (up to about 0.3 percent) and is the most important source of this metal. Also germanium is commonly present as a trace or in small amounts. *Jordisite* is the colloidal MoS_2-modification.

Molybdenum is not susceptible to supergene sulphide enrichment and migrates little, if at all, in the oxidized zone. But in the zone of weathering it may become oxidized to the blue oxide, ilsemannite, forming a tarnish on molybdenite, or to the yellow molybdite, but these minerals do not long survive their parent. Powellite, another oxidation product of molybdenite, is inconspicuous in daylight but fluorescent in ultraviolet light.

In some cases molybdenum, as a part of apomagmatic solutions, is deposited as *wulfenite* together with galena and sphalerite. Wulfenite is a soft mineral and contains theoretically 26 % Mo, 56.4 % Pb, and sometimes subordinate amounts of Ca. It occurs in the oxidation zone of Pb (-Mo) deposits, mainly in the form of tabular or pyramidal crystals, locally replacing calcite and galena. Wulfenite is a minor contributor to the world molybdenum production, though in Northern Europe it is of no economic importance. Wulfenite forms an isomorphous series with stoltzite, $Pb\,W\,O_4$.

Ferrimolybdite, also called molybdite or molybdic ochre, is usually found in the form of earthy masses or fibrous aggregates, natural crystals being rare. Normally it is an alteration product of molybdenite. In countries where oxidation zones are developed, ferrimolyb-

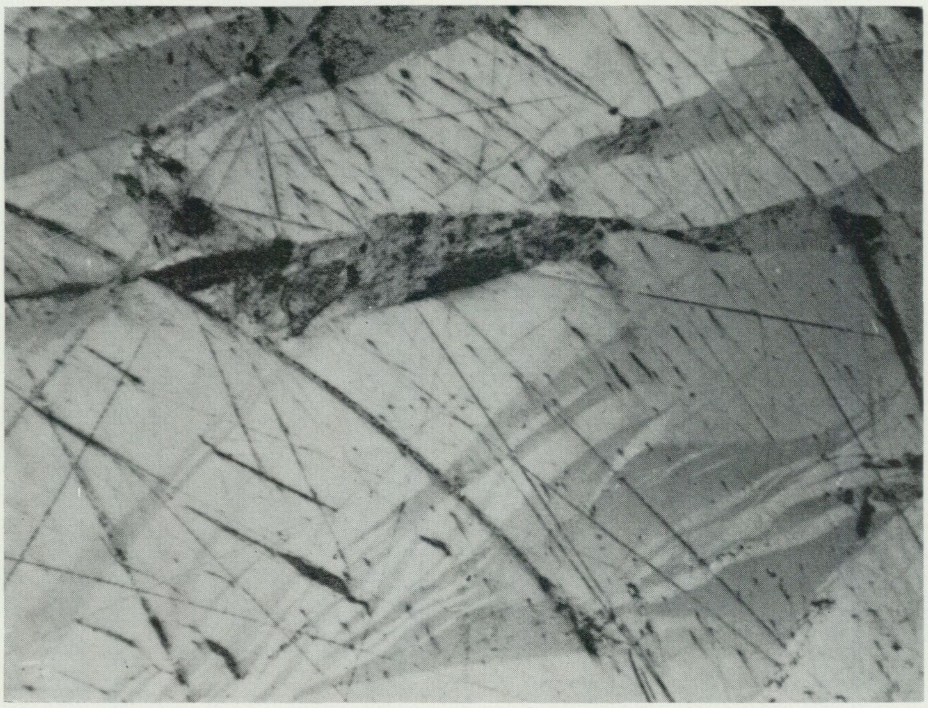

Fig. 1. Molybdenite aggregate showing reflection pleochroism (light grey to dark grey); the gangue is black. Pol. sec., 50x. BLYBERG.

dite may serve as a guide to underlying molybdenite. In Sweden it appears erratically, for example in the Bispberg and Öraberg deposits. Flink (1910) also has reported ferrimolybdite occurring at Lerviken (Nya Kopparberg), Linnås (Alseda), and "Överkalix".

Powellite occurs usually in subordinate amounts, as small dipyramids and thin tabular crystals, representing an alteration product of molybdenite. It can replace molybdenite, and alters to ferrimolybdite. Normaly it is without economic significance (Ödman 1950, pp. 23–26).

Ilsemannite is the blue molybdic oxide; this secondary mineral forms earthy blue and black masses or crusts, and is soluble in water.

Lindgrenite and *Koechlinite* are other rare secondary molybdenum minerals.

The detection and determination, and prospecting methods for molybdenum have been treated *inter alia* by Jeffery (1953), Kauranne (1958), Kelly (1940), North (1956), Reichen & Ward (1951), Vokes (1963), Ward (1951), and in Eng. Mining Journal (1942, 143:9).

The only important ore mineral is molybdenite, although wulfenite has been mined in a few places abroad for its molybdenum content. Small amounts of molybdenite (aggregates in pegmatite and quartz veins) have earlier been won by hand-picking, especially during war time. But normally molybdenite is concentrated by means of *flotation*, the oil-flotation process having been utilized for the first time in 1913 for the Kvina molybdenum ores in the vicinity of Knaben, Norway.

Usually the run-of-mine ore is subjected to crushing and grinding in a rod/ball mill, the pulp then entering the flotation cells in a coarse flotation circuit. Oversize from the fine screens may be diverted by gravity to an elevator which returns it to the mill for regrinding. After passing a fine flotation circuit the high grade molybdenum concentrate can be sent to a spiral rake thickener for thickening prior to filtration.

Molybdenite responds very readily to flotation and can easily be recovered as a good grade concentrate if phyllosilicates (as for example chlorite) are not abundant. If ores contain noteworthy amounts of chalcopyrite, or other copper minerals, the concentrate may carry undesirable amounts of copper unless special ore dressing methods are used.

Standard grade concentrate contains 90 % MoS_2 although concentrates containing as low as 80 % are marketable under special conditions. Impurities should not exceed 0.5 % Cu, 0.3 % Pb, and 0.1 % P.

Most of the molybdenite produced (about 60 percent) is roasted to molybdic oxide (MoO_3), but small amounts of concentrate are used directly as an additive in steel-making processes; or in purified form, after reflotation and acidizing, they may be used for lubricants.

3.2. Tungsten Minerals

Ore mineral	Chem.formula	Metallic Content	Colour	Crystal System	Specific Gravity
Scheelite	$CaWO_4$	63.9 % W	White to amber	Tetragonal	5.9–6.1
Wolframite = isomorphous series ranging from	$(Fe,Mn) WO_4$	51.3 % W (average)	Black to brown	Monoclinic	7.0–7.54
Ferberite	$FeWO_4$	60.6 % W	Black	Monoclinic	
to					
Hübnerite	$MnWO_4$	60.7 % W	Brown	Monoclinic	
Tungstite (tungsten ochre)	$WO_3 . H_2O$		Greenish-yellow	Earthy masses (orthorhombic)	4.6

More than ten tungsten minerals are known, but the only ores are scheelite and the minerals of the wolframite group.

Scheelite is commercially the most significant tungsten mineral. It forms as isomorphic series with powellite ($Ca Mo O_4$) and usually appears as individual crystals. The colour and lustre cause it to resemble some common non-metallic minerals such as calcite, felspar, barite, and quartz. As a good field test Gisler (Denver Equipment Company, 1962) suggests placing a small drop of hydrochloric acid on the suspected mineral and sawing it for about 15 seconds with a clean blade of a knife; if it is scheelite, the cut turns blue-grey, and if the knife blade is wiped on white paper, the blue stain is well demonstrated. The blue cut darkens in a few minutes and disappears within an hour.

But fluorescence has become the most extensively applied tool for the detection of scheelite in the field, and it is extremely useful in helping to evaluate scheelite deposits and in sorting the ores. Scheelite fluoresces under short wave ultraviolet light; a test may be made on outcrops or boulders at night, and under a dark cover during the day. In underground mine workings the amounts of scheelite present may be estimated by measuring the fluorescent areas.

Scheelite (and its molybdian variety powellite) is the only ore mineral of tungsten that fluoresces, the colour ranging from blue to yellow with increasing molybdenum content; manganese, a rare constituent, seems to give a similar effect. It is, however, hardly necessary to mention that there are other minerals that give almost the same fluorescent effect as scheelite.

Scheelite rather than wolframite is preferentially formed under pegmatitic-pneumatolytic conditions, where the environment consists of limestone or other carbonaceous rocks; it is thus the typical W-mineral in the contact-metasomatic skarn deposits of Central Sweden.

Scheelite, however, commonly occurs in economic quantities in a much lower temperature environment; for instance it may appear with or without such minerals as fluorite and gold in relatively low grade schists where an igneous source cannot be possible. Where the source is magmatic (for example, King Island in Australia) Mo may be a deleterious containment, as very rarely, under exceptional environments, may Nb, Ta and rare earths.

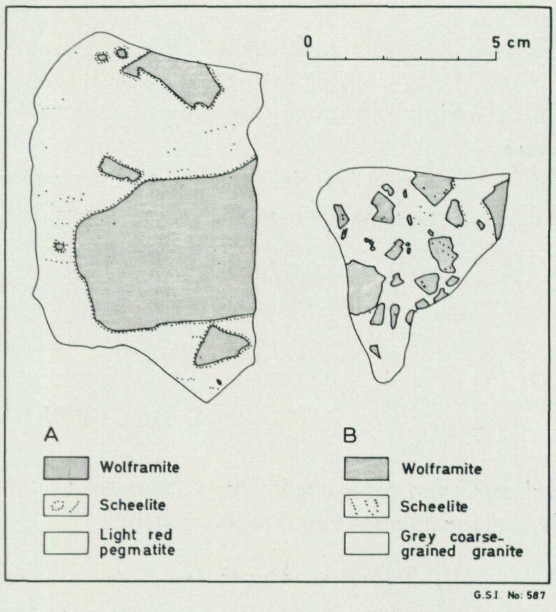

Fig. 2. Wolframite and scheelite crystals, Baggetorp Mine.

The minerals of the *wolframite* group represent an isomorphous series ranging from ferberite ($Fe WO_4$) to hübnerite ($Mn WO_4$). These minerals show a darker colour with increasing iron content. Wolframite is relatively hard, and usually forms prismatic or lamellar crystals which are well cleaved. Rarely it also occurs as fibrous aggregates.

Wolframite is difficult to identify positively in the field as it closely resembles other heavy, dark-coloured minerals. Exceptionally it may have inclusions or a rim of scheelite (Fig. 2), or it may have replaced scheelite in the metallogenic process.

Wolframite can contain CaO, Nb and Ta-oxides, and rare-earth metals, and if some magnetite is admixed, the ore will show magnetic effects. Wolframite does not fluoresce under short wave ultraviolet light. In alluvial, and particularly eluvial ground, both wolframite and scheelite may be detected by panning, but their relatively brittle nature prevents them from travelling as recognizable grains far from their original habitat.

Genetically the minerals of the wolframite group are usually bound to pegmatites and pneumatolytic deposits (in cases together with quartz, cassiterite, molybdenite, fluorite, apatite, and tourmaline). Wolframite is the main ore mineral of the Baggetorp occurrence. The accessory wolframite at Yxsjö seems to represent a ferberitic modification (Magnusson 1940, p. 168). Pure ferberite or hübnerite are relatively rare and usually to be found in low-temperature hydrothermal veins.

Tungstite, also called tungsten ochre, occurs as earthy masses grown on wolframite. Only artificial crystals are known.

The tungsten minerals *stoltzite* β – Pb (WO_4) and *welinite* $(Mn^{+4}, W)_{<1}$ $(Mn^{+2}, V, Mg)_{\sim 3}$ Si $(O, OH)_7$, in Sweden occurring at Långban, are only of mineralogical interest.

Methods for detection and determination of tungsten and grading of its deposits have *inter alia* been described by Gisler (1962), Greenwood (1943), Jeffery (1953), Jolliffe & Folinsbee (1942), McLaren (1943), North (1956), and Wilson & Fieldes (1944).

The commercial tungsten ores, scheelite and wolframite, require *concentration* to yield a marketable product. Generally the WO_3 content of the run-of-mine ores is less than one percent, and ores with up to 3 percent are considered high grade. The ores, which usually are readily concentrated, because of their high specific gravity, are first refined to a content of about 65 percent WO_3 and are then given different chemical treatments depending on whether the oxide, the tungstates or the metal are wanted.

Scheelite ores are usually concentrated by means of gravity and flotation, wolframite by gravity and magnetic separation. Gisler (Mineral processing flowsheets, Denver Equipment Company, 1962) has presented a short summary of the different methods used for simple and complex ore types. The standard grades for concentrates are 65 % WO_3 for wolframite and 60 % for scheelite. Tolerance of impurities varies under different contracts but the maxima allowable without penalty are about as follows: Sn 1.6 %, As 0.2 %, Cu 0.10 %, P 0.05 %, Sb 0.05 %, Bi 0.40 %, S 1.0 %, and Pb less than a few tenths of one percent.

Scheelite concentrate of sufficiently high grade (at least 70 % WO_3) and low in undesirable impurities can be used for direct addition to steel smelts. Lower grade products often are subjected to further treatment by chemical means. In this case, the impurities are separated or removed chemically and the dissolved tungsten precipitated to form artificial scheelite, which is then marketable in accordance with special specifications concerning grain size.

4. OCCURRENCES IN SWEDEN

As molybdenum and tungsten in many cases occur together, their deposits are treated together here.

4.1. Types of Deposits

Apart from molybdenum and tungsten contained in bituminous shales, the Mo- and W-mineralizations are, with few exceptions, directly or indirectly connected with granitic and pegmatitic intrusions probably related to sialic-palingenic magmatism. Molybdenum and tungsten are preferentially concentrated in the late products of magmatic fractionation. Both follow the subsequent pegmatitic and pneumatolytic to katathermal stages.

The classification presented here conforms broadly with Routhier's (1963) concept. Concerning the pneumatolytic to hydrothermal occurrences, which mainly are to be found in Northern Sweden, the scheme is based on Grip's (1951) comprehensive study; see p. 12.

Summarizing, the occurrences show the following distribution within the various groups:

Fig. 3. Medium-grained red granite (grey on photo) invaded by dolerite dykes (dark grey); pit about 150 m northeast of BISPBERGS KLACK.

Type of mineralization (see table, Fig. 5)		Number of occurrences*		Percent
Intra-plutonic	I 1	7		5.1
	I 1, 2	5		3.7
Pegmatitic	I 2	19		14
Contact-metasomatic (pegmatitic to pneumatolytic)	I 3 A	38		
	I 3 A (representing transitions to groups I 5 E, F, G)	6	57	41.9
	I 3 A, B	3		
	I 3 B	10		
Pegmatitic-pneumatolytic	I 4	8		5.9
Pneumatolytic to hydrothermal	I 5	2		
	I 5 A	1		
	I 5 A–G	4		
	I 5 B, D	1	20	14.7
	I 5 C	3		
	I 5 C–G	4		
	I 5 F	2		
	I 5 G	3		
	Undefined	20		14.7
	Total	136		100.0

* Mineralizations within restricted areas, such as the Riddarhyttan mine area, have in this summary been considered as one occurrence.

4.1.1. Mineralization in Granitoid Rocks

Molybdenite and scheelite occur as accessory constituents of granitoid rocks, the mineralization being normally bound to the upper or peripheral parts of acidic plutons. Molybdenite and scheelite, together with iron sulphides, chalcopyrite, and fluorite, appear in Central Sweden as disseminations in Late Svecofennian granite. Also the molybdenite impregnations in Gothian granite in the southwestern part of the Kopparberg County (Hjelmqvist 1966, p. 191) should be cited here. The mineralizations related to Bohus granite in southwestern Sweden belong to groups I 1 and I 2. In relation to the host rock most of the occurrences in granitoid bodies have to be classified as syngenetic.

The Pingstaberg and Bispberg occurrences may serve as examples of disseminated deposits.

The *Pingstaberg area* is situated west of the southern end of Lake Hörken. Leptites with limestone-layers, skarn and iron ore have been invaded by a stock of Late Svecofennian granite with granitic and pegmatitic apophyses. The supracrustal rocks are well exposed at Kalkåsgruvan, about 800 m south of the top of Pingstaberg Mountain (plate XI). There is a limestone lens about 40 m long bordered by a skarn mantle, within grey leptite; the limestone is white, coarse-grained and contains garnet and green skarn minerals. Northeast of the abandoned limestone quarry massive garnet-bearing skarn with molybdenite and scheelite has been exposed in a trench. The skarn is brecciated and veined by quartz and calcite (Fig. 8). Barnfallsgruvan, 400 m northeast of Kalkåsgruvan, is a skarn iron ore deposit, invaded by aplite, pegmatite, and metabasite.

The granitic stock covers a surface area of about 0.5 by 1.5 km. Intermittent molybdenum and tungsten mineralization has been encountered in the southern part within an area of 0.5×0.5 km, east of the above mentioned mines. The intrusive is of Malingsbo-type, medium-grained and mainly consisting of quartz, microcline, plagioclase (chiefly oligoclase), biotite, and in

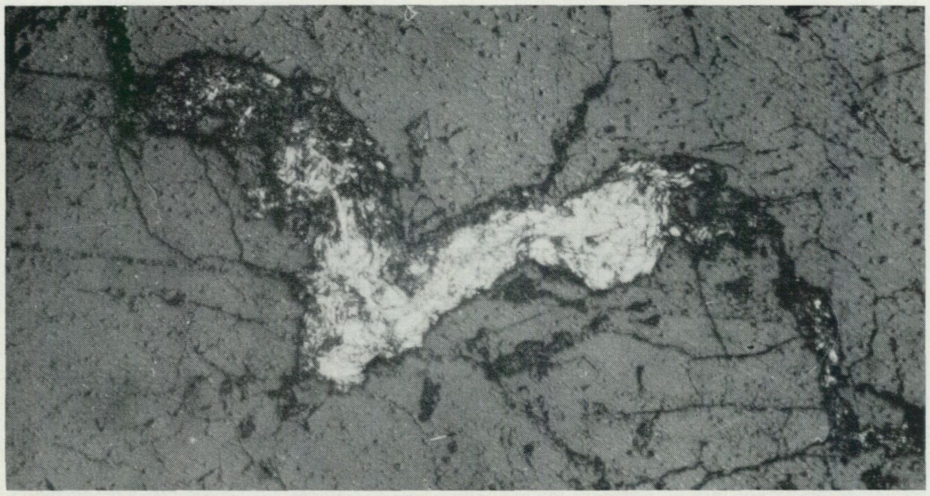

Fig. 4. Molybdenite (white) filling joint at the boundary between granite (grey, upper part of photo) and vein quartz (grey, lower part); pol. sec., 56x. BISPBERGS KLACK.

	TYPE OF DEPOSIT	HOST ROCK	TYPE OCCURRENCES IN SWEDEN		MINERAL ASSOCIATION
			Molybdenum	Tungsten	
I RELATED TO GRANITOID PLUTONS	1 In the granitoid body	Granite, granodiorite	Pingstabergsfältet east of Yxsjöberg, Algruvan, Bispberg	Pingstabergsfältet east of Yxsjöberg	molybdenite, scheelite, pyrite, chalcopyrite fluorite
	2 Pegmatitic	Pegmatite, aplite, pegm. quartz (and adjacent country rock)	Uddgruvan		molybdenite, pyrite, chalcopyrite quartz, microcline, chlorite, epidote, apatite, titanite, asphalt
	3 Contact - metasomatic (pegmatitic to pneumatolytic)	A Pegmatite and quartz veinlets, skarn, carbonaceous rocks, amphibolite	Hörken mines Örabergsgruvan	Yxsjö mines	molybdenite, scheelite, pyrrhotite, chalcopyrite, pyrite, wolframite, Bi-minerals fluorite pyroxene (hedenbergite), amphibole,garnet (grossularite-andradite), quartz, felspars, carbonate
		B Iron ore, skarn	Ickorrbotten		molybdenite, magnetite, skarn minerals, scheelite
	4 Pegmatitic-pneumatolytic	Pegmatite, aplite, quartz and adjacent gneissose country rock	Iggöhällan	Baggetorp	molybdenite, pyrite, chalcopyrite quartz, felspars, mica wolframite, molybdenite, scheelite, pyrite, chalcopyrite, pyrrhotite quartz, felspars, mica, skarn minerals
	5 Pneumatolytic to hydrothermal	A In compact sulphide ores or off - shots	Lainijaur	Boliden, Lainijaur	scheelite, pyrrhotite, arsenopyrite, chalcopyrite, sulphominerals, pyrite, sphalerite skarn minerals molybdenite, Ni - As minerals (Lainijaur)
		B In breccia-sulphide ores and ore veins	Kristineberg, Laver		molybdenite, chalcopyrite, pyrite, pyrrhotite, sphalerite skarn minerals
		C Bound to quartz veins, in places containing tourmaline and calcite	Kristineberg	Boliden, Kristineberg	molybdenite, scheelite, quartz, tourmaline, pyrite, calcite, and other minerals (see Ödman 1941, pp. 83-96)
		D In or related to basic dykes		Boliden, Laver	scheelite, sulphominerals, pyrrhotite
		E In sericite and chlorite schists, quartzite (altered rocks)		Boliden, Kristineberg	scheelite, pyrrhotite, pyrite, chalcopyrite, sphalerite sericite, chlorite, quartz
		F In skarn	Lindsköld (Adak)	Långdal, Lindsköld	scheelite, molybdenite clinozoisite and other skarn minerals
		G In unaltered metamorphic rocks		Boliden	pyrrhotite and other sulphides
II	IN SEDIMENTARY ROCKS	Black shales	Cambrian "alum shales", Central Sweden		molybdenite,(molybdenum in solution precipitated by hydrogen sulphide) tungsten mineral not determined (probably wolframite) Iron sulphides, graphite, uranium etc.

Fig. 5. Classification of molybdenum/tungsten deposits.

Fig 6. Molybdenite (white to light grey) in quartz (dark grey); pol. sec., 56x. UDDGRUVAN. See p. 15.

places muscovite. The colour of the granitic rocks varies between reddish and grey. Granite dykes of the above mentioned kind have also invaded the leptite-amphibolite complex and the Barnfallsgruvan iron ores.

Molybdenite disseminations, commonly accompanied by iron sulphides and violet fluorite appear both in reddish and in grey granite. The mineralizations usually are extremely sparse, although local concentrations are to be found in granite near the contact with leptite to the west. Within this sector Brundin & Palmqvist (1939–1940) found the strongest geochemical anomalies. As plate XI shows testpits have also been sunk, and drilling has been carried out.

The *Bispberg* mines were worked at the end of World War II. The "Bispbergs Klack" massif consists chiefly of so-called Enkullen granite, a Late Svecofennian fine- to medium-grained granite with rectangular microcline phenocrysts (usually about 1 cm in size). The workings are in medium-grained red to grey granite, in places cut by northeasterly trending dolerite dykes of Åsby-type which dip steeply to the southeast (Fig. 3).

The dumps contain mainly granites of the above mentioned type, red aplite, and pegmatite. The red granite is locally of pegmatitic character and veined by quartz and calcite.

Molybdenite forms disseminations in red and grey granite, pegmatite and aplite. Commonly it appears close to quartz veins, and on slickensides. The Mo-mineralization seems to be more concentrated in the grey granite variety and in the parts rich in quartz. Also fluorite, iron sulphides, chalcopyrite, ferrimolybdite, scheelite, bornite, galena, and Bi-minerals have been met with. Only the richer parts of the mineralized granite have been exploited. The mines are abandoned and the pits flooded.

Here should be mentioned that molybdenite, together with chalcopyrite and galena, also occurs in magnetite ore in small workings west of the Storgruvan iron deposit (Bispbergsfältet west of Bispbergs Klack). In connection with sulphide mineralization the leptitic country-rock has been altered to fluorite-bearing almandite-quartzite (Hjelmqvist 1966, p. 180).

Algruvan (Lillhärad), another molybdenum occurrence in granite, has during 1943–1945 yielded 3 550 tons of molybdenum ore.

4.1.2. Pegmatitic Deposits

Deposits of this kind are mainly to be found in Central and Northern Sweden. Pegmatites in the first mentioned region contain molybdenite, pyrite, chalcopyrite, scheelite, and almost without exception they are connected with Late Svecofennian granitic intrusives. In Northern Sweden the pegmatites with subordinate amounts of molybdenite and pyrite are chiefly related to Lina-type granites.

Pegmatite and aplite veins, emanating from granitoid bodies, in many cases grade into quartz veins. Molybdenite is normally concentrated at the boundary between the acidic veins and the adjacent rock. However, impregnations can also be found in the veins. Molybdenite occurs as flakes, well-developed large hexagonal crystals, or radial clusters and aggregates, and as coatings on the rock-forming minerals. Scheelite, if present, appears in the vicinity of pegmatite/aplite veins, and

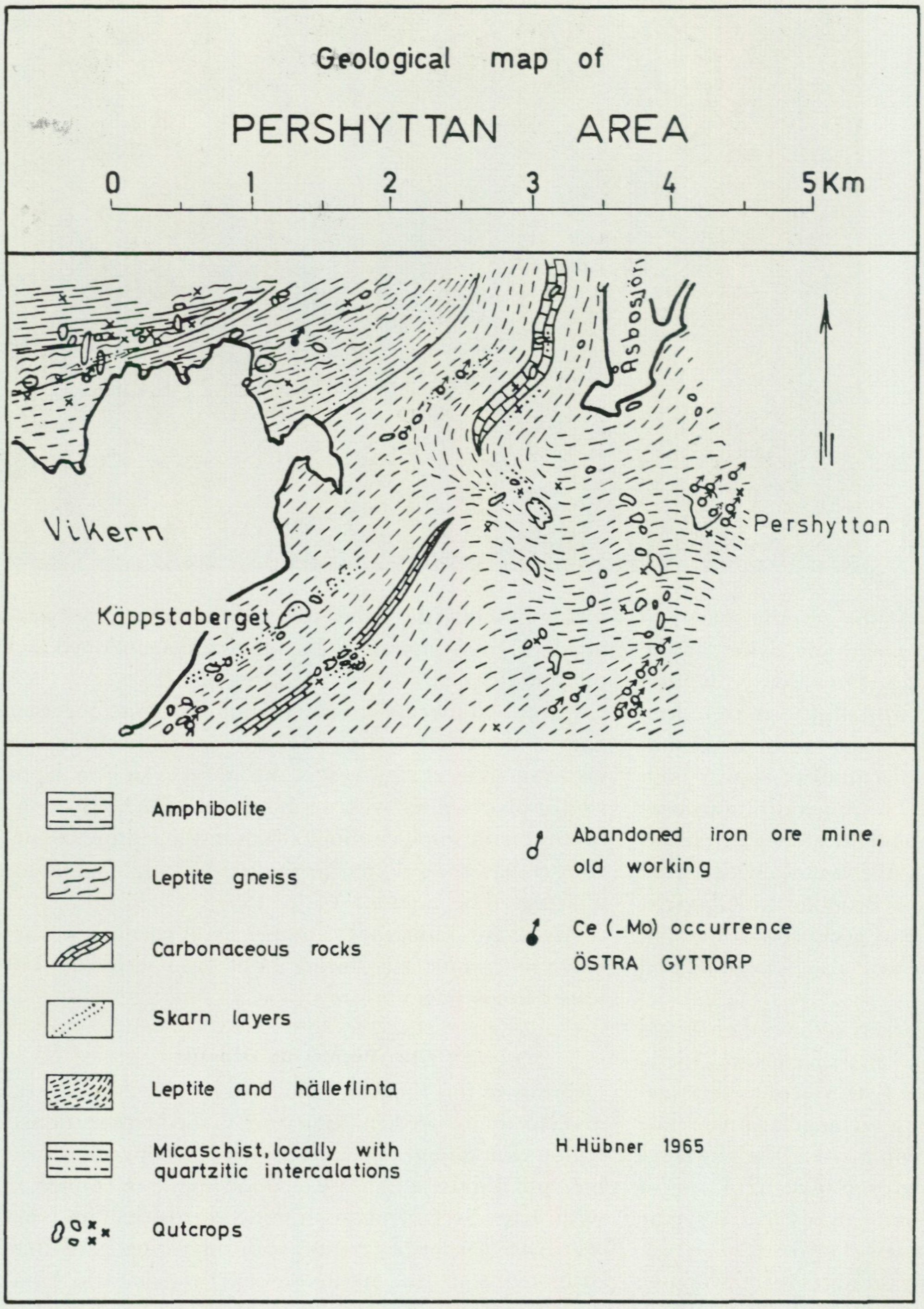

Fig. 7. Geological map of Pershyttan area.

chiefly in carbonaceous rocks such as skarn and limestone.

With few exceptions pegmatitic molybdenum deposits, are rarely of economic interest.

An example of a pegmatitic quartz vein is *Uddgruvan*, located about 3 km south of Grängesberg. Eklund has given a short description in Tegengren's symposium (1924, pp. 230–232). This deposit, which seems to be the richest molybdenum occurrence in Sweden, has been worked intermittently from the end of the last Century until 1920.

The mineralization forms lenses in quartz-pegmatite (up to 10 m wide and 50 m long) plunging steeply to the south-southwest. The pegmatite is conformable with the country rock which is porphyritic leptite showing a north-northeasterly strike. In the vicinity of the

Fig. 8. Quartz (white) veining skarn. S: compact green skarn. G: garnet skarn. KALKÅSGRUVAN.

ore-body the leptite is red-grey to grey, banded, and locally skarn-bearing (garnet, epidote). At depth both the quartz-pegmatite and the adjacent leptite are cut by a granitic dyke.

Molybdenite appears in the form of impregnations and stringers in quartz (in places with garnet), microcline, skarn, and leptite. Molybdenite also occurs as large and well-developed crystals and aggregates, and as coatings in sheared quartz. Eklund reported that the average MoS_2 grade in the run-of-mine ore varied between 0.6 and 1.2 percent, the highest grade and biggest mineralized area having been observed at the lowermost level at 55 m depth.

The main periods of exploitation were during the second half of World War I and World War II. The reserves are practically exhausted. Today only a water-filled pit, ruins of a concentration plant, and several dumps are left. The area is being covered by tailings from the Grängesberg concentration plant.

Another molybdenum occurrence which should be mentioned here is *Östra Gyttorp* (Fig. 7). This mineralization represents an intermediate type between groups I 2 and I 3 A. A skarn-magnetite body is bordered by leptite. Quartz lenses with molybdenite, and orthite lenses are known both in leptite and in amphibole-chlorite skarn.

4.1.3. Contact-metasomatic Deposits

Numerous examples of high-temperature replacement deposits, which belong to the pegmatitic-pneumatolytic P-T range, are known in Central Sweden.

Calcareous sedimentary rocks, or skarn formed by regional metamorphism, have been invaded by granitoid intrusions or pegmatites. This process led to the formation of skarn, mainly consisting of pyroxene, garnet and amphibole. Molybdenite chiefly occurs in this new skarn generation, connected with pegmatite and quartz veinlets. Reaction between alkaline ore-bearing solutions and calcareous matter could readily result in the formation of calcium tungstate (scheelite) in limestone, massive skarn, skarn-bearing iron ore, and amphibolite. These contact-metasomatic occurrences also commonly contain notable amounts of fluorite formed by reaction between volatile fluorine compounds and calcareous material. Finally, both tungsten and molybdenum follow hydrothermal solutions rich in silica and are deposited in the form of wolframite, scheelite, and molybdenite in quartz veins.

Deposits of contact-metasomatic character are usually small, erratic in grade, and local concentrations are restricted, but such occurrences have been worked in Sweden during periods of extreme shortage and elevated prices – conditions prevailing during the World Wars.

The tungsten and molybdenum mineralizations of "Yxsjö-Hörken" type have been described *inter alia* by Magnusson (1940, p. 83 ff.), who has also ably characterized the occurrences in the Ljusnarsberg ore province. These mineralizations are related to Late Svecofennian granites and its pegmatitic apophyses invading limestone or amphibolitic rocks. Reaction products are typical skarn minerals such as garnet (dominantly grossularite) and hedenbergitic pyroxene accompanied by iron sulphides and chalcopyrite. The skarn masses and adjacent leptite are usually veined by pegmatite, quartz and calcite (Fig. 8). Violet and white fluorite commonly appears both in pegmatite and skarn.

As the *Yxsjö* tungsten occurrences have previously been treated in detail by Lindroth (1922) and Magnusson (1940, pp. 165–171), only a short summary is presented here.

Scheelite and sulphide-bearing bodies are located in a leptite complex which extends to Lake Norra Hörken in the east, and which about 7 km west of Lake Yxsjön, is bordered by a massif of Järna-type granite. The country-rock belongs to the "lower leptite division" and contains limestone intercalations which are partly or completely metamorphosed into skarn. This complex was later folded and in places invaded by Early Svecofennian granites. Basic magma was consequently intruded into leptite and granites along fractures, and appears today in the form of amphibolitic dykes with east-northeasterly and northerly trends. These basic intrusive rocks are undoubtedly younger than the above mentioned granites and older than the scheelite-bearing skarn and the pegmatites.

In connection with pegmatitization of the leptite complex the limestone bodies have partly been altered to skarn and pegmatite-rich rocks. Within the western part of the mine area (Norra and Södra Yxsjögruvan) at least three northwesterly-trending relatively well preserved limestone layers seem to exist. In the eastern part of the mine area (Kvarnåsgruvan and Nävergruvan) a mineralized amphibole-skarn body, probably representing a limestone bed completely altered to skarn, has been worked.

In 1922 Lindroth published a study of the geology of the entire area and the mineralogical composition of the various skarn types. These skarn rocks, which in many cases are rich in granitic components of pegmatitic character, seem genetically to be related to Late Svecofennian granites, such as the Pingstaberg intrusive. The most important skarn minerals are hedenbergite poor in magnesium, Ca-Al garnet, and amphibole rich in iron and potash; epidote, biotite and chlorite are minor constituents, whilst also quartz, felspar, fluorite, and scheelite occur in subordinate amounts. Scheelite and fluorite frequently appear together, a high fluorite content indicating a high W-grade. Finally, the skarn-masses also contain sulphides such as pyrrhotite, chalcopyrite, and pyrite, with accessories such as magnetite, titanite, apatite, wolframite (ferberite), bismutite and native bismuth.

The Yxsjöberg area has initially been worked for copper (chalcopyrite) probably discovered in the beginning of the 18th century. The tungsten occurrences were first mentioned by Igelström in 1862. In 1917 scheelite was won by handpicking at Nävergruvan. As the mineralization encountered in the dumps was relatively rich, exploratory mining was started at Nävergruvan and Båtgruvan during the first half of 1918, and a small ore-dressing unit was built, but as the concentrate was not of satisfactory grade, and due to falling prices after World War I, the dressing plant was abandoned early in 1920. This period of production yielded 7 016 tons of run-of-mine ore. 5 270 tons of crude ore and an additional 1 135 tons of hand-picked ore, totally containing 93 tons of WO_3 were treated yielding 37 tons of scheelite concentrate containing 20 tons of WO_3.

Mining started again in 1935, and from this year on the exploitation increased steadily. According to the Official Mine Statistics the production for years 1938–1963 is 2 696 181 tons of run-of-mine ore. The average grade of the crude ore is estimated at 0.3–0.4 % WO_3. The Yxsjö Mines were abandoned in autumn 1963 but production will, however, probably be resumed in autumn, 1971. During the initial period material from dumps originating from the thirties and forties will be re-concentrated in the new beneficiation plant.

The ore bodies to be worked are located between the 250 m and 450 m levels. The excavated material will be crushed underground in three stages to a grain size below 30 mm and hoisted from the 450 m level. According to E-S Brunnsjö (1971, p. 11) the following flow sheet will be applied:

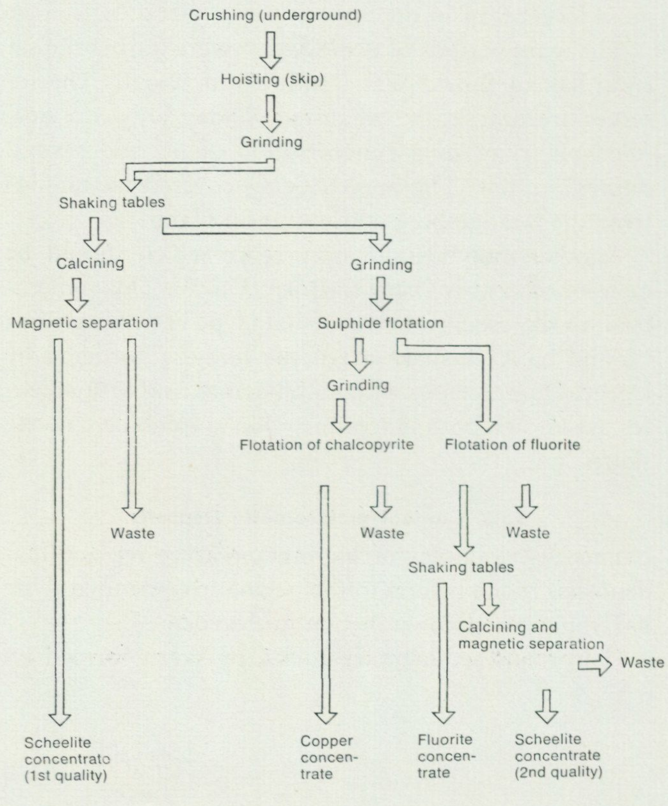

Fig. 9. Slightly deformed molybdenite flakes (white) in a matrix consisting of sericitized plagioclase and carbonate (dark grey); pol. sec., 70x. HÖRKEN MINES.

The scheelite concentrate is supposed to average 72 percent WO_3. The copper concentrate will hold 25 percent Cu, and the fluorite concentrate 95–96 percent CaF_2. The latter-mentioned product will mainly be used as an additive for welding rods and partly also as metallurgical flux.

The production envisaged for the first years is 150,000 tons of crude ore plus 20,000 tons of barren rock per annum, corresponding to about 500 tons of scheelite concentrate. This production will probably be increased to 0.2 MTPA of run-of-mine. The ore reserves have been estimated to cover about fifteen years at the above-mentioned rate of exploitation.

The Yxsjö tungsten-copper occurrences have previously been mined by shrinkage stoping; this method will probably be applied during the initial period, and may subsequently be replaced by cut-and-fill mining.

The *Hörken* mines represent pegmatite-skarn occurrences with molybdenite and sparse scheelite impregnations. The country-rock is leptite with metamorphic basic dykes, pegmatite and aplite grading into quartz masses. Phlogopite and serpentine-bearing limestone and iron ore appear in places as remnants in pyroxene-amphibole-garnet-epidote skarn. In the southern part of the mine area (Älvgruvan claim) granite also has been met with. Molybdenite forms impregnations in skarn, pegmatite and quartz, in the adjacent skarn-bearing leptite and in amphibolite. The molybdenite flakes are frequently found at the contact between garnet and pyroxene/amphibole, and between skarn and pegmatite/quartz. The molybdenum mineralization is accompanied by fluorite, pyrrhotite, pyrite, chalcopyrite, and scheelite in subordinate amounts (average WO_3-grade below 0.1 percent). The essential data about the various mine properties are presented in the Appendix. Totally only 120 tons of crude ore were produced.

According to the Mining Statistics the *Öraberg* deposit, being of the same type as the above mentioned occurrences, has yielded the following production (ore sent to the concentrator):

YEARS	TUNGSTEN ORE	W-Mo ORE
1944–1945		27 489 tons
1942–1943, and 1946	27 191 tons	

The *Ickorrbotten* iron ore deposit (Geijer & Magnusson 1944, p. 347, and Tegengren 1924, p. 204) could be cited as an example of group I 3 B. A north-northeasterly trending zone of iron occurrences extends from Våghalsgruvan (southwest of Ludvika) under Lake Väsman to Iviken and, east of the contact with older Svecofennian granites, for another 15 km to the north-northeast. The iron ores are predominantly quartz-banded sedimentary hematite and magnetite ores bound to leptite and micaschist.

The Högbotten orebody within the Ickorrbotten mine area also contains skarn minerals (Fe- and Mg-amphiboles, pyroxene, garnet, and quartz) and shows sulphide impregnations consisting of pyrite, molyb-

Fig. 10. Banded grey gneiss with leptite layers, intercalated with basic gneiss (dark grey); white to light grey-pegmatite veins. IGGÖHÄLLAN.

denite, chalcopyrite, bornite, together with scheelite and fluorite. Molybdenite, locally forming rich impregnations in iron ore, was mined at the end of World War I to yield 3 216 kgs of molybdenite concentrate with 40 % Mo.

4.1.4. Pegmatitic-pneumatolytic Deposits

This group comprizes pegmatitic-pneumatolytic mineralizations which are not of contact-metasomatic character. Few occurrences of this type have been explored. One of them (Mo) is located in veined gneiss which is mainly of sedimentary origin and conforms with the southern edge of the Central Norrland geosyncline, whilst another (W, Mo), bound to quartz-aplite intruded into veined gneiss, is broadly at the southern boundary of the Svealand anticlinorium.

Iggöhällan, an island (size about 200 by 650 m) in the Baltic Sea, is situated 1 km north of Iggön in Gävle Bay. The northwestern part is rich in outcrops, and only the southeastern end is completely covered by Quaternary sediments. About twenty trenches and test pits are located in the northwestern central part of the island.

The country-rock is veined gneiss, of granodioritic composition. Its strike is west-northwesterly, and the dip 75° SW to vertical. The gneiss complex makes up part of the Hamrånge syncline. In detail the rock consists of banded grey gneiss with leptitic layers, intercalated with basic biotite (amphibole) gneiss. The complex is invaded by pegmatite, which in places cuts the above mentioned rock sequence. Assimilated gneiss remnants in pegmatite have been observed. Vague graded bedding indicates that the top of the sequence is to the southwest.

Molybdenite mineralization appears in the form of impregnation zones, more or less parallel with the general strike of the gneiss complex. Two main zones show dimensions of about 30×200 m, and 10×100 m. Molybdenite impregnations are bound to veined gneiss rich in biotite and amphibole. The mineralization is frequently to be found at the boundary between gneiss layers and pegmatitic stringers, in the central parts of pegmatite veinlets, and in pegmatitized partly assimilated gneiss remnants. Locally, also, extremely sparse impregnations consisting of iron sulphides and chalcopyrite have been encountered. The average grade of the mineralized zone, however, does not seem to exceed 0.1 % Mo. The sulphide invasion is undoubtedly related to the pegmatitization. The regional geology has recently been dealt with by Lundegårdh (1967).

The *Baggetorp* tungsten occurrence (Plate XII) was developed during and shortly after World War II. Magnusson (1953, p. 320) has presented a short geological description as follows: "wolframite, and molybdenite in subordinate amounts together with other sulphides such as pyrite and chalcopyrite, appear in a quartz-aplite mass which has intruded older veined gneiss of Sörmland type. The quartz-aplite mass is cut by dykes of small and equigranular granite, which seems to belong to and emanate from the adjacent porphyritic granites. These are related to the so-called Småland granites, in which the veined gneiss with the intruding quartz-aplite mass form a partly assimilated remnant. Towards the contact with this remnant the porphyritic granites show transitions into small and equigranular types similar to those encountered in the above mentioned dykes".

The mine is now abandoned. The dumps show grey and frequently pegmatitized gneiss, grey gneissose leptite, grey gneissose granite with basic remnants, red aplite, red pegmatite, vein quartz, fine to medium-grained red granite, dark-green skarn with garnet and epidote, and dolerite. Pegmatite and quartz veins contain wolframite crystals (up to a few cm in size) which in cases show rims and small inclusions of scheelite (Fig. 2). Molybdenite was observed in pegmatitized grey gneiss and skarn (frequently on slickensides), in red granite, and together with pyrrhotite and wolframite in red pegmatite. Locally chalcopyrite appears in skarn. The reddish rocks, i. e. granite and pegmatite, are younger than the grey coloured ones, cut and vein grey gneiss and gneissose granite.

The Mining Statistics give the following production figures (metric tons) for crude ore mined at Baggetorp including Algruvan:

PERIOD	TUNGSTEN ORE	W-Mo ORE
1944–1947, 1954–1958	136 096	
1948–1953		142 169

Algruvan, located in the eastern part of the mine area, has yielded 22.5 tons of MoS_2.

4.1.5. Pneumatolytic to Hydrothermal Mineralization

Molybdenum and tungsten occurrences of this type are chiefly found in the Västerbotten county. They are obviously connected with ore-forming processes which seem to be related to Late Svecofennian folding, migmatization, and granitization (Revsund granites), and to granites of Adak-Lina type. As Grip (1951) has already presented an excellent description of the tungsten and molybdenum mineralizations occurring in basemetal sulphide ores in Northern Sweden, it is not necessary to repeat this information here, but the more important data are summarized in the Appendix.

An occurrence which possibly belongs to this group is *Haukok* in the Rappen area. Indications of molybdenum mineralization, chiefly local boulders, have been encountered over a length of approximately 20 km. Molybdenite, iron sulphides, scheelite, and probably also hübnerite appear in the form of impregnations in gneiss and granite. In connection with mineralization the gneiss has been sericitized and silicified. Skarn, intercalated in gneiss, frequently is scheelite-bearing. Reportedly the granite is older than the Lina granites, and younger than the Arvidsjaur granites.

A prospecting campaign, carried out by the Geological Survey, also comprised about ten boreholes drilled during summer 1970. The first core analyzed held 0.8 percent MoS_2 over a length of 23.7 m. This section is bordered by a wide alteration zone with impregnations of molybdenite, pyrite and traces of chalcopyrite.

4.1.6. Molybdenum and Tungsten in Paleozoic Shales

Under favourable conditions heavy metals are precipitated in sapropelic sediments, and in exceptional cases even concentrated to a mining grade like the so-called "Kupferschiefer". According to Rankama and Sahama (1960) bituminous shales in Eastern Fennoscandia contain up to 40 ppm Mo and up to 80 ppm W. The Lower Paleozoic alum shales in Central Sweden reportedly show molybdenum contents of up to 330 ppm. These sapropelic bituminous sediments presumably have been deposited in shallow marine basins.

The alum shale group in Närke is mainly Upper Cambrian in age. The shales contain only thin limestone intercalations and are relatively rich in bituminous substance. The total thickness, however, does not exceed 20 m.

In Västergötland the greatest part of the Middle Cambrian sequence and the entire Upper Cambrian are developed as alum shales with intercalations of bituminous limestone, showing a maximum thickness of 23 m. Also in Östergötland the alum shale facies is well represented, but is not quite as thick as in Västergötland.

The alum shales in Scania (thickness up to about 100 m) continue through the Cambrian series into the Lower Ordovician.

Finally, Middle and Upper Cambrian alum shales also are locally to be found in Jämtland, both in the autochtonous sequence and in nappes.

Secondary molybdenum and tungsten deposits, such as those in the above mentioned shales, are too low in grade to have economic importance at the present time, but the possibility of recovering Mo, W, and other metals as a by-product of eventual uranium exploitation should be kept in mind.

If uncalcined shale is leached only a few percent of the molybdenum content can be recovered. In order to achieve a maximum recovery the material should first be calcined and then be leached by very acid or alcalic (natrium carbonate) solutions.

4.2. Geographical Distribution and Metallogenic Considerations

In Central Sweden, where most of the molybdenum and tungsten occurrences are concentrated, the mineralizations are almost without exception associated with *Late Svecofennian granites*. These serorogenic acidic intrusives are generally massive, and rich in quartz and felspar. The granites, which have probably been mobilized by palingenic processes, normally cut older structures, but are sometimes conformable with them. In general the intrusives are accompanied by pegmatites which in places contain molybdenite, iron sulphides, chalcopyrite, and fluorite.

The molybdenum mineralizations in southeastern Sweden (Jönköping and Kalmar counties) are essentially related to *Småland granites* belonging to the Gothian cycle, although the Ekholmen occurrence is in granodioritic gneiss which forms part of the Svecofennian rocks.

The age of the Baggetorp W–Mo deposit is uncertain, but the mineralization could be connected with the intrusions of Småland-type granites, or with Late Svecofennian migmatitization.

The molybdenum mineralizations in southwestern Sweden seem mainly to be related to *Bohus granite* and accompanying pegmatites. These acidic intrusions, rich in potassium, belong to the Dalslandian cycle.

In the zone of the *veined gneisses* in southern Norrland granitic material has invaded older supracrustal rocks, resulting in the formation of migmatites. Iggöhällan would be an example of molybdenum mineralization in veined gneiss, due to palingenic processes and pegmatitization.

In Västerbotten the known molybdenum and tungsten occurrences are chiefly connected with sulphide ores, quartz veins, or basic dykes. The molybdenum mineralizations in the Norrbotten county are dominantly bound to *Lina-type granites*. These rocks are Late Karelian in age and generally considered to represent late-orogenic intrusions.

Summing up, with regard to tungsten and molybdenum, the following main metallogenic cycles can be distinguished:

	Metals
1. Granites and pegmatites belonging to the Late Svecofennian period (Central and Northern Sweden)	Mo, W
2. Lina-type granites and pegmatites (Karelian cycle)	Mo
3. Gothian granites (Southeastern and Central Sweden)	Mo
4. Bohus granite (Dalslandian cycle)	Mo

However, by far the most important metallogenic process is related to the mobilization and intrusion of the Late Svecofennian granites. As Grip (1951, p. 471) already has pointed out, the occurrences bound to pegmatites and skarn in Central Sweden represent a deeper section of the Earth's crust than the mineralizations in the Skellefte and Arvidsjaur Districts. Generally speaking, the occurrences in Central Sweden have been formed under conditions of higher temperatures than those in Västerbotten.

Molybdenite and scheelite are in places accompanied by pyrrhotite and subordinate amounts of chalcopyrite. The association molybdenum/tungsten and that of copper could, however, be due to different phases of mineralization.

There is an obvious lack of occurrences between Iggöhällan in the south and the Skellefte District in the north, a gap which is undoubtedly due to several causes. The country-rock of the barren region consists to a great extent of veined gneisses, schists and greywackes, which a priori are poor in mineralizations. On the other hand the Skellefte District with its numerous sulphide occurrences has been subjected to intensive prospecting, and consequently the density of discoveries is greater. In connection with mapping and prospecting carried out by the GEOLOGICAL SURVEY OF SWEDEN and private groups in the Norrbotten and Västerbotten counties, also, numerous erratic boulders with molybdenite and chalcopyrite have been found in moraine and peat-bogs. However, it is difficult to trace the mineralized outcrops only by considering the relation between the location of ore boulders and the direction of glacial striae, especially in regions where 99 percent of the bedrock is covered by Quaternary sediments, peat-bogs and lakes.

5. PRODUCTION, COSUMPTION, PRICES AND USES

5.1. Molybdenum

The total production from Swedish occurrences is estimated at about 200 tons of MoS_2, more than half of it originating from Uddgruvan. No deposit is being worked at present.

Consumption in Swedish basic metal industries in 1968, tons
(Source: Official Statistics of Sweden, Metal & Mining industries)

Consumed for production of	Ferro-alloys	Crude steel
Molybdenum ores, calcined		890
„ „ others	3415	
Ferro-molybdenum		3062

U.S.A. is the largest producer of molybdenum and has since 1925 contributed more than half the world supply. Molybdenum is chiefly supplied from Climax (Colorado) being the world's largest single producer, Endako (Canada) and other mines in British Columbia and Quebec, and is also recovered as a by-product from copper ores, mainly in North and South America. In Chile plans were made to increase the molybdenum recovery as a by-product of copper mining to about 25 millions lbs per year by 1970. During the last years the expansion of established mines and the advent of new producers, as for example the Urad mine in Colorado (developed by American Metals Climax, Inc.) has brought further improvements in the supply situation.

Generally speaking, the iron and steel industry accounts for the consumption of about 90 percent of the world molybdenum supply. Free World molybdenum consumption increased during the early 1960s at an average rate of about 7 percent a year. In 1967 it was estimated at 112 million lbs compared with 111 million in 1966. Free World mine production was estimated at 126 million lbs. Both in 1967 and 1968 supply exceeded the demand. According to Mayers (1969) the total Free World supply in 1968 was 135 million lbs of contained molybdenum (U.S. mine production 94, other Free World production 38, and G. S. A. sales 3 million lbs in concentrates). The Free World consumption in 1968 was estimated at 119 million lbs in concentrates.

Quotations are normally in cents or shillings per pound of MoS_2 contained in concentrate. Mining Journal (vol. 274, No. 7021) quoted the molybdenum prices as follows (LME, March 12, 1970):

ORE	Molybdenite (85 %) MoS_2 14s 4d per lb. Mo f. o. b. Climax
METAL	Molybdenum powder 30s/40s per lb.

Molybdenum is mainly consumed in the form of molybdic oxide, ferromolybdenum, molybdenum powder, molybdates, and purified MoS_2 added to lubricants or steel. The consumption, especially for constructional low-alloy steel, stainless steel, and high-temperature application, has shown a tremendous development since the beginning of this century. Prior to 1900 only about 10 tons of molybdenum had been produced.

By far the largest *use* of molybdenum is in the iron and steel industry where advantage is taken of the unique properties this metal imparts to various iron and steel products. Addition of molybdenum, in the form of oxide or ferro-molybdenum, promotes uniform hardness, hardenability and toughness in steel and cast iron. Alloyed in steel molybdenum acts like tungsten, but requires only 1/2 to 1/3 as much in quantity in order to yield similar qualities as tungsten. Molybdenum is also an essential component of stainless steel. Other important uses are as an additive to non-ferrous alloys; as pure metal for a material of construction; and in the form of chemical compounds for pigments, paints, and sulphur-resistant catalysts which are used for the production of high-octane petrol. Among other applications, molybdenum is used extensively to produce electrodes for processes requiring high purity, thermocouples, and also for furnace and brake linings. In Scandinavia molybdenum compounds are incorporated in fertilizers.

Both in the traditional, and newer fields of application such as electronics, nuclear energy and missile techniques molybdenum's potentialities are undoubtedly very great.

Prices of Molybdenum Ore

EUROPE

Conc. min 85 % MoS_2. Per lb. Mo. F.o.b. Climax basis.†

1966			1967		
July	12	11/9	March	3	11/7
	15	11/1	November	21	13/9
			November	24	13/6
1969					
May	9	14/4			
December	31	Unchanged			

† Source: Metal Bulletin. Dates given are those of issues recording price change.

UNITED STATES

Molybdenum Concentrates. lb. Mo cont. 95 % MoS_2, f.o.b. shipping pt.

Climax, cost of container extra

1964			1967		
April	3	$1.55	January	11	$1.62
1969					
May	7	$1.72			
December	29	Unch.			

Source: Metals Week.

5.2.2 Tungsten

In *Sweden* the only occurrence of significance is that of the Yxsjö Mines (see Appendix), but the mines were abandoned in autumn 1963 due to extremely low quotations on the world market. In 1969 the property, which previously was in private hands, was purchased by the Government Mining Company and the exploitation is expected to start again in 1971.

A. Holmquist has estimated the W-content of concentrate obtained from tungsten ores from the Yxsjö, Baggetorp, and Öraberg mines (production 1936–1963) at about 5 550 metric tons.

Consumption in Swedish basic metal industries in 1968, tons
(Source: Official Statistics of Sweden, Metal & Mining industries)

Consumed for production of	Ferro-alloys	Crude steel
Tungsten ores	221	15
Ferro-tungsten		747

By far the largest *producers* are China and the U.S.S.R., which in 1967 accounted for an estimated 17.6 million lbs and 13.6 million lbs, respectively, out of an estimated world production of 61.5 million lbs of contained tungsten (Mining Journal, 1969). Here should be mentioned that Climax, the world's largest producer of molybdenum, also produces tungsten (1.4 million lb in 1967) as a by-product of its molybdenum operations.

The *price* of tungsten has always been very sensitive to the interaction of supply and demand. With falling quotations many primary producers have been compelled to suspend operations, causing alternate shortages and over-supply. Due to the flood of Sino-Soviet metal at the beginning of the last decade the price of tungsten was forced down to levels at which only few producers in the Free World could stay in business. Later on the situation was reversed, and Eastern European countries became buyers of tungsten from Western producers. Demand for tungsten in 1967 was reduced from the record high in 1966 but remained above that of prior years. The price of tungsten in the United States remained at or near $43 a short-ton-unit of WO_3, c.i.f US ports, duty paid (1 short-ton unit is 20 pounds of WO_3, and contains 15.862 pounds of W). Recently the prices have become more steady and an annual rate of growth of about nine percent has been predicted for the tungsten market during this decade. Mining Journal (vol. 274, No. 7021) has presented the following LME quotations (March 12, 1970):

ORE	Wolfram and scheelite (65 %) 730s–765s per 1 ton unit WO_3*
METAL	Tungsten powder (98/99 % W) 52s 3d per lb. metal

Neither molybdenum nor tungsten were used commercially prior to 1900 although it was an important but unsuspected component of the legendary Damascus steel. Tungsten alloy steel was later discovered to be vastly superior for cutting metal at high speed and caused a sensation at the Paris Exposition in 1900. Tungsten can be heated to higher temperatures without softening than any other substance except carbon because its melting point is the highest of all metals. It also has the highest tensile strength of any known metal.

Nowadays, the chief *use* for tungsten is still for making high-speed cutting steels which retain their hardness even at red heat. These alloys contain up to 20 percent tungsten with some chromium and vanadium. Nearly all alloy steels containing tungsten are made in the electric furnace where tungsten is introduced in the form of ferro-tungsten (normally with 70–80 % tungsten).

Some of the tungsten reduced to metallic form is utilized in making cemented carbides, the hardest known artificial substance. WC is the basic material for a great variety of cemented or sintered carbide cutting tools, dies and wear-resistant parts. The carbides are mainly used for such tools as milling cutters, reamers, punches and drills; as dies for wire and tube-drawing; and for wear-resistant parts of gauges, valve seats and guides. Large amounts are also used by the mining industry as carbide-tipped rock-drill bits (Wigle, 1967).

In high-temperature nonferrous and superalloy fields, where temperature resistance requirements are beyond the ability of highly alloyed steels, tungsten is used as a base-alloy with varying amounts of cobalt, chromium, molybdenum, nickel, or other refractory metals to produce numerous hard, heat- and corrosion-resistant alloys. "Stellite", for example, is an alloy of tungsten, chromium and cobalt, for hard facing materials. Tungsten is indispensable as filament wire in incandescent lamps but its consumption for this purpose is small, being only one to two percent of the annual total production. Apart from the above mentioned applications tungsten is utilized for magnet steel, spark plug electrodes, welding rod for atomic hydrogen process, cathodes of X-ray equipment, photoflashbulbs, television and X-ray screens etc.

* The grading, analysis, and marketing of tungsten ore is usually based on the tungsten tri-oxide (WO_3) content and not on the metal content. Scheelite, the principle ore, for example, when pure, assays 80.6 % WO_3, and wolframite, 67.3 % WO_3.

Tungsten carbide has been the largest area of growth during recent years, for example through the production of snow tire studs. The growing manufacture of large aircrafts and missiles represents a promising potential use.

Prices of Tungsten Ore

WORLD

Wolfram ore, standard quality, min. 65 % WO_3. Per long ton unit WO_3, c.i.f.†

1968					
Jan.	23	407/6–425/0	June	28	357/6–377/6
	26	405/0–425/0	July	2	365/0–390/0
Feb.	2	397/6–427/6		5	377/6–397/6
	6	402/6–422/6		9	385/0–405/0
Mar.	5	400/0–420/0		12	392/6–412/6
	15	375/0–395/0		16	392/6–415/0
	19	365/0–380/0		30	395/0–415/0
	22	350/0–365/0	Sept.	24	387/6–407/6
	26	345/0–360/0		27	377/6–397/6
	29	342/0–352/0	Oct.	1	370/0–390/0
Apr.	2	332/6–342/6		8	362/6–377/6
	5	325/0–335/0		11	355/0–370/0
	9	317/6–332/6		22	350/0–370/0
	11	315/0–327/6	Nov.	1	355/0–375/0
	19	310/0–322/6		5	360/0–380/0
	23	307/6–320/0		8	370/0–385/0
	26	295/0–320/0		12	377/6–392/6
	30	295/0–315/0		15	385/0–400/0
May	7	290/0–315/0		19	390/0–405/0
	17	297/6–317/6		22	397/6–422/6
	21	297/6–322/6		26	410/0–430/0
	24	302/6–330/0		29	420/0–435/0
	28	310/0–335/0	Dec.	3	422/6–437/6
	31	320/0–345/0		6	427/6–440/0
June	11	330/0–350/0		10	430/0–445/0
	14	335/0–357/6		13	432/6–447/6
	18	340/0–365/0		17	435/0–447/6
	21	347/6–367/6		24	435/0–450/0
	25	350/0–375/0			
1969					
Jan.	10	437/6–450/0	June	20	422/6–437/6
	17	430/0–450/0		27	420/0–440/0
	28	425/0–445/0	July	8	425/0–440/0
	31	410/0–430/0	Oct.	31	430/0–440/0
Feb.	4	400/0–425/0	Nov.	7	430/0–442/6
	7	400/0–420/0		11	432/6–444/6
	11	397/6–412/6		14	432/6–450/0
Mar.	28	395/0–410/0		18	440/0–460/0
Apr.	3	390/0–405/0		21	450/0–470/0
	11	385/0–405/0		25	455/0–480/0
	15	382/6–402/6		28	475/0–495/0
	18	365/0–380/0	Dec.	2	485/0–510/0
May	2	367/6–385/0		5	500/0–530/0
	6	370/0–390/0		9	535/0–570/0
	9	375/0–400/0		12	570/0–610/0
	13	395/0–410/0		16	580/0–630/0
	20	402/6–417/6		19	590/0–640/0
	23	407/6–422/6		23	600/0–645/0
	30	417/6–432/6		31	600/0–650/0
June	3	420/0–435/0			

† Source: Metal Bulletin. Dates given are those of issues recording price change.

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INDEX OF LOCALITIES

Roman numbers refer to plates

Explanatory Notes For Plates I—VIII

The Appendix (plates I–VIII) contains all data, available to the author, about 150 molybdenum and tungsten occurrences in Sweden, comprizing name, county, district, important metals, stage of development, host rock, country rock, ore minerals and gangue, type of deposit, mine workings and their location, production and grade (if known), importance of deposit, and references. A similar type of scheme has previously been used by Bazin & Hübner (1969).

The occurrences are listed according to counties and, more or less, in sequence from south towards the north. As most deposits worked are of small size the term "abandoned mine" also has been used for properties which yielded only a restricted production during war times.

When describing the host rock the expression "green skarn" has been applied in a few cases. This term refers to compact skarn consisting of green silicates, i. e. amphibole and/or pyroxene.

The term "Late Svecofennian granite", "Younger Svecofennian granite", "Younger Archean granite", and "Late Svionian granite", used by various authors for late-orogenic acidic intrusives in Central Sweden (younger than the so-called urgranites) are, more or less, synonymous. The expression "older and younger granites" when describing the country-rock in Central Sweden refers to Early and Late Svecofennian granites, respectively. The Early Svecofennian intrusives, also called "urgranit", represent synkinematic rocks.

The occurrences are classified according to host rock, their metallogenic character, and mineral association see Fig. 5), but this classification should be regarded as tentative, as several occurrences cover more than one type of mineralization. In various cases it is doubtful if deposits should be placed within the pegmatitic-pneumatolytic or pneumatolytic-hydrothermal range.

The following abbreviations have been used in plates I–VIII:

KEY TO ABBREVIATIONS USED IN TABLES

Ore minerals

ars	arsenopyrite
az	azurite
bis	Bi-minerals
bor	bornite
boul	boulangerite
cc	chalcocite
cov	covellite
cp	chalcopyrite
ga	galena
he	hematite
ma	magnetite
mal	malachite
mar	martite
mo	molybdenite
mol	ferrimolybdite
py	pyrite
pyrr	pyrrhotite
sche	scheelite
sp	sphalerite
wo	wolframite

Importance of deposit

U	Unknown
N	None
S	Small
M	Medium

O.W.	Old workings
P	Production
G	Grade

Gangue

act	actinolite (incl. grammatite)
am	amphibole i.g.
ant	anthophyllite
apa	apatite
apl	aplite
bi	biotite
c	calcite (& other carbonates)
chl	chlorite
cor	cordierite
di	diopside
ep	epidote
fl	fluorite
fs	felspar i.g.
gar	garnet i.g.
gro	grossularite
hed	hedenbergite
hor	hornblende
mcl	microcline
mi	mica i.g.
mu	muscovite
or	orthite
peg	pegmatite
phl	phlogopite
pyr	pyroxene i.g.
Q	quartz
sca	scapolite
se	sericite
ser	serpentine
sc	scapolite
ti	titanite
wl	wollastonite
zo	zoisite (incl. clinozoisite)

Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned prospect	Abandoned mine	Host rock	Country rock	ORE MINERALIZATION		Gangue	Type of deposit	Mine workings, location	Developed during	COMMENTS	References	Importance of occurrence
ASARYD	KRONOBERG ASA	Mo, Au	X			Grey to grey-red granodiorite with basic remnants, at the contact between peg and diorite	Småland granite, granodiorite, diorite, gneiss, leptite, peg, apl, Q	Sparse impregnations	mo,py	fl	I 1,2	Located about 7 km southwest of Ramkvilla	Forties	Several test pits and trenches southeast of a small lake, located a few hundreds of meters northwest of Lake Skären. Reportedly analyses of picked specimen have shown up to 60 g/t Au	A. JOHNSON & Co. (correspondence 1948)	N
VIKTORSGRUVAN	JÖNKÖPING Alseda	Mo			X	Peg ?	Gabbro-diorite, Småland granite, older granite	Impregnations ?	mo		I 2 ?	Situated about 8 km SE of Vetlanda, and 0.5 km SE of Lindås	World War I	Abandoned pit, filled with debris; a road passes over the working. In the vicinity outcrops of grey-red medium-grained granite, peg, and greenstone with Fe-sulphides have been met with. P (1917): totally 100 tons, including only 3 tons of hand-picked ore with 3% Mo	Tegengren 1924, p. 65	N
ALSEDA	JÖNKÖPING Alseda	Mo	X			Red peg, and grey to red-grey granite (mo + py)	Småland granite and older granite	Local impregnations	mo, py		I 1,2	Approx. 10 km ESE of Vetlanda, and 3.3 km south of Alseda church		Two test pits in outcrop of medium-grained grey-red to grey granite with peg, Q, and a dolerite dyke	Discovered in connection with geophysical prospecting carried out by A. JOHNSON & Co., Dept. of Mines	N
SUNNERSKOGS COPPER MINE	JÖNKÖPING Alseda	Cu, W (?)	X				Småland granite, older Gothian granite, Gothian sedimentary rocks		Sche					Reportedly sche has been met with in the dumps and also in a drive		U(N)
ÖSTRAHULT	KALMAR Misterhult	Mo	X			Diorite, forming inclusion in granite	Småland granite	"Veinlets"	mo			Located approximately 12.5 km north-northwest of Oskarshamn		Reportedly mo appears in the form of veinlets in diorite which is bordered by granite. At the indicated locality only light-red granite with felspar phenocrysts (without sulphide mineralization) has been encountered	Svedmark 1904, pp. 40-41 Tegengren 1924, p. 343	N
BANKHULT	KALMAR Kristdala	Mo	X			Pegmatite vein in light red medium-grained granite	Småland granite	Local impregnation	mo	peg	I 2	Ancient claim situated about 1.5 km SSE of Bankhult	Early sixties	Investigated by northeasterly trending trench (1 x 8 m)	Svedmark 1904, pp. 40-41 Tegengren 1924, p. 344	N
RAMNEBO	KALMAR Misterhult	Mo Cu, Pb	X			Red-grey medium-grained granite, locally silicified	Småland granite	Local mineralization	mo cp, ga, Fe-sulphides	Q		Situated about 2 km south-southwest of Mörtfors village		According to Tegengren, west of Ramnebo mo has been encountered in the form of fine-grained flakes together with cp, py and ga. Approximately 800 m west of Ramnebo two water-filled trenches are to be found in red-grey granite. The dumps contain granite with peg-veinlets and "ore quartzite" with pyrr, cp, and traces of ga. No mo-mineralization was observed.	Tegengren 1924, p. 343	N
HÄLLESJÖN	KALMAR Hjorted	Mo	X			At the contact between Q-vein and granite	Småland granite	Local mineralization	mo	fl	I 2	Located approximately 7 km WNW of Ankarsrum		At the southwestern bay of Lake Hällesjön, 75 m SW of the shore, a 0.5 m wide ma-bearing peg-Q veinlet is to be found in red medium-grained granite (without sulphides) Identical with "Hällsjön", cf	Svenonius 1905, p. 58 Tegengren 1924, p. 343	N
BORGÖ	KALMAR Västervik	Mo	X			Peg ?	Småland granite, "Gothian" sedimentary rocks	Local impregnation	mo			Situated approximately 4.5 km south of Västervik city		Reportedly mo has been observed about 100 m west of the westernmost farm on Borgö (south of Lucernafjärden). At this locality a contact between gneissose diorite and granitized (and pegmatitized) metaarenite was encountered. The contact zone is rich in peg veinlets, but no sulphide mineralization was seen	Svenonius 1907, p. 43 Tegengren 1924, p. 343	N
LÖGARBERGET	KALMAR Lofta	Mo	X			Quartzite	"Gothian" sedimentary rocks	Local impregnations	mo		I 5 G	Lögarberget north of Gamleby viken (about 1 km north of the city of Västervik)		Discovered in connection with prospecting campaign for uranium	A. JOHNSON & Co	N
SANDEBO	KALMAR Lofta	Mo, Cu	X			Mineralization at the contact between quartzite and py-bearing Q-veinlets	"Gothian" sedimentary rocks	Local impregnation	mo, cp, Fe-sulphides	Q	I 5 C	Two small trenches located approximately 6 km NW of Västervik (at the beach, west of the landing-site for steamers)		The mineralization is of local character. West of Sandebo farm quartzite and diorite without any sulphide mineralization were encountered. The outcrops east of the ancient landing-site show grey to red-grey quartzite with basic inclusions	Svenonius 1907, p. 43	N
EKHOLMEN	KALMAR Östra Ed	Mo, Cu		X		Mineralization at the contact between grey granodioritic gneiss and peg - Q veinlets, also in peg and Q	Basic volcanics altered to veined gneisses	Sparse impregnations	mo, pyrr, cp, py	Peg, Q	I 2	Island situated about 500 m northwest of Stora Askö, 26 km NNE of Västervik	About 1880, World War II	Two water-filled pits (2 x 6 m, depth about 5 m) located at the southwestern beach of the island. The country rock consists of grey granodioritic gneiss with up to o,5 m wide peg-Q veins. The width of the mineralized zone tested by the workings does not exceed a few dm, and its extension is limited. A trench stripping granodioritic gneiss with peg and Q veinlets and traces of cp, py and mo is about 50 m NW of the above mentioned workings. Reportedly sparse mo impregnations are to be found in the cliff of Stora Askö (opposite Ekholmen, about 500 m SE of the pits) and at several other places on St. Askö	A. Gavelin 1904, p. 69 Hoppe 1886, p. 63 Tegengren 1924, p. 343	N
BJÖRNDALEN	KALMAR Dalhem	Mo, Cu			X	Micaschist,leptite; at the contact between supracrustal rocks and peg veins, rarely also in peg	Granite, granodiorite, leptite, quartzite, micaschist	Impregnations (in supracrustal rocks, the mo flakes are parallel with schistosity)	mo pyrr, cp		I 4	Water-filled pit (3 x 25 m) and dump located approx. 600 m south of Larums old copper mine, and 3.5 km north of Dalhem village	World War I	Mineralization bound to metamorphic supracrustal rocks forming a remnant in granodiorite, the latter bordered by granite to the south. In the vicinity of the pit banded leptite and dark-grey gneiss are to be found. The dumps show grey and in places gneissose leptite, micaschist (locally ma-bearing) and grey quartzite. The supracrustal rocks contain peg veins and are intruded by granite. Outcrops northwest of the mine : granite and granodiorite ---"--- east ------"-----: grey gneissose leptite with peg veinlets and red granite P (1917): totally mined 550 tons, including 34 tons of run-of-mine ore with 0.9% Mo. Mineralization limited in extent.	Svenonius 1914, p. 71 Tegengren 1924, p. 65, 343	N
JÄNTBYGGET	KALMAR Ukna	Mo	X									Located approx.25 km SE of Åtvidaberg		Mineralization located about 500 m SW of Ukna church	Sandegren & Sundius 1928, p. 44	U(N)
RÖDBÄCKEN	ÖSTERGÖTLAND Gryt	Cu, Mo	X											Abandoned copper mine	Asklund & Sandegren 1923, p. 3	U(N)
TIMMERGATA	ÖSTERGÖTLAND Krokek	Fe, Cu, Mo	X			Skarn, peg	Leptite, limestone, oldest granites, peg	Local impregnation	cp, mal, mo Fe-sulphide ma		I 3 A	Situated about 6 km east of Krokek village	Claim staked in 1915 and 1951	Two samples of hand-picked ore held A: 4.28% Cu and 0.07% Mo B: 1.26% Cu, 0.12% Mo, 0.03% Zn, 0.11% Pb, 0.7% S, 14 g/t Ag About 300 m north of the beach of Bråviken Bay a water-filled pit (3 x 25 m) with west-northwesterly trend and a trench were met with. The dumps contain ma-bearing skarn with sparse pyrr mineralization. Red peg, and granite with leptite and gneiss remnants are to be found nearby. West and east of pit several outcrops of hor-gneiss, veined gneiss, and pegmatite with scarse Fe-sulphides and mal on slickensides were encountered	A. JOHNSON & Co (correspondence 1951, 1953)	N
BAGGETORP	ÖSTERGÖTLAND Tjällmo	W, Mo, Cu			X	Peg, apl, Q-veins, granite, gneiss, skarn	Granite with fs porphyrobl. (Småland granite), veined gneiss, fine to medium-grained granite, peg, apl, dolerite	Impregnations, local concentrations	wo, mo, sche py, cp ,pyrr	Q, peg,apl	I 4	Abandoned mine (several pits and trenches) Claims: Baggetorpsgruvan, Algruvan, Nordgruvan, Dikesgruvan	Late forties	Mineralization mainly in Q and apl intruding veined gneiss ("Sörmland gneiss"), both cut by granite dykes. The dumps contain grey gneiss with pegmatite veinlets, grey gneissose leptite, grey gneissose granite with basic remnants, red apl, red peg, vein-Q, fine to medium-grained red granite, gar-ep skarn, dolerite. wo with rims of sche appears locally in peg and Q-veins. mo has been encountered (in many cases on slickensides) in grey gneiss and skarn, in red granite, and together with pyrr and wo in red pegmatite. cp has locally been observed in skarn. The red-coloured rocks (granite, peg) are younger than the grey rocks, intrude and cut grey gneiss and gneissose granite. P (1948): 6800 tons of run-of-mine ore	Magnusson 1953, p. 320	S

Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned Prospect	Abandoned mine	Host rock	Country rock	Ore mineralization		Gangue	Type of deposit	Mine workings, location	Developed during	Comments	References	Importance of occurrence
BROBERG	BOHUSLAN Brodalen	Mo	X			Grey-red medium-grained granite	"Bohus granite," gneiss, pegmatite	Local mineralization in joints	mo, pyrr		I 1	4 ancient claims situated approx. 16 km NNE of Lysekil, and 1 km SE of Bro village (south of Brobergsdammen)	1952	mo has been encountered locally in a small granite quarry	AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH (correspondence 1952-1953)	N
BARHULT	GÖTEBORG	Mo	X			Peg	St. Le-Marstrand series, Kroppefjäll granite		mo		I 2	8 km north of Munkedal			Brotzen 1959, p. 263	U(N)
KINNA	ÄLVSBORG Kinna	Mo	X			Peg	Gneisses, mainly grey	Local impregnation	mo		I 2	A 7 m deep water well located on A. Tranings estate, 1:a Vallåsgatan, Graninge.	1935	mo appeared in red pegmatite cutting red fine to medium-grained granite. The well is abandoned and not accessible.		N
HEDE	ÄLVSBORG	Mo	X			Peg	Kroppefjäll granite		mo		I 2	20 km northeast of Munkedal			Brotzen 1959, p. 263	U(N)
BREVIK	ÄLVSBORG Tösse	Cu, Mo	X			Mylonitized (schistose) granite with quartz veinlets	"Åmål granite"	Local impregnation	cp, mal, mo		I 5 C (I 4)	2 small granite quarries situated about 5,5 km south of Åmål, and 50 m west of Lake Vänern		The abandoned quarries are located in grey-red granite cut by a N 10°E striking tectonic zone		N
SKENHALL	VÄRMLAND Trankil	Mo, Cu	X			Grey-red fine to medium-grained granite, peg and apl-veins; at the contact between granite and peg-apl veinlets	"Bohus granite," diorite, "Åmål granite," and rocks belonging to "Stora Le - Marstrand" series	Impregnations	mo cp, py		I 1,2	Mineralized outcrops and trenches in the vicinity of Skenhall village	Discovered in 1939 by Eng. J. Berglund, exploration intermittently (1965)	Mineralization encountered intermittently within an area covering about 1.5 sq km, located west of Lake Lelången. mo-impregnation seems inter alia to appear within a <50 m wide west-northwesterly trending zone between Lake Lelången in the east and the road to Lennartsfors in the west. G: probably less than 0.2% MoS_2.	A. JOHNSON & CO., Dept. of Mines (correspondence 1939, 1940).	U
MALSJÖ	VÄRMLAND Grums	Mo	X			Quartz vein	Grey banded garnet-bearing gneis with peg veinlets	Local impregnation	mo py		I 4	An about 0.5 mm wide quartz vein is located at the road near Malsjö Gästgivaregård (about 3 km NNW of Grums village			Igelström 1850, 1851 Tegengren 1924, p. 214	N
MALSJÖ	VÄRMLAND	W	X			Carbonate rocks			sche			Limestone quarry			Lindroth 1922	U(N)
GULLSJÖ	VÄRMLAND	W	X			Carbonate rocks			sche			Limestone quarry			Lindroth 1922	
ÅKERGRUVAN	VÄRMLAND Kroppa	Fe W	X		X	Skarn	Leptite, skarn, iron ore, granite (numerous dykes)		sche		I 3 A	Located about 13 km SE of Filipstad		Nykroppa iron ore mines Skarn minerals, gar, pyr, act, Mg-am, mi, chl, chondrodite, spinell, sc	Geijer & Magnusson 1944 p. 191 Lindroth 1922	N
TORSKEBÄCKS-GRUVAN, JORDÅSGR.	VÄRMLAND Persberg	Fe W	X		X	Skarn	Skarn with iron ore, leptite		sche, Fe-sulphides, bis	fl, sc	I 3 A	Situated about 3 km east and 1.5 km NE of Persberg railway station respectively		gar-pyr skarn	Geijer & Magnusson 1944 pp. 185-188 Lindroth 1922	N
GRUNDSJÖGRUVAN KOGRUVAN	VÄRMLAND Nordmarken	Fe W	X		X	Skarn (?)	Leptite, skarn, gabbro-diorite, Filipstad granite		sche			Located approximately 5 km NE of Nordmark			Lindroth 1922	U(N)
LÅNGBAN MINE DISTRICT	VÄRMLAND Färnebo	Fe, Mn, Ag, Cu, Pb, Zn, Mo, W &others	X			Skarn, carbonate rocks, iron ore	Limestone and dolomite, leptite, greenstones, schist, granites	Sparse impregnations	mo (near granite contact), sche (with py in hematite, with C in dolomite)	fl	I 3 A,B	Famous mine district situated approximately 17 Km NNE of Filipstad		Deposits well known for their variety of minerals (more than 100, including rare Mn and Pb minerals). Dolomite quarry	Magnusson 1930, pp.58-59, 61	N
BRÄNNMOSS-GRUVAN	VÄRMLAND Gustav Adolf	Mo, Cu			X	Skarn-bearing leptite, amphibolite, pegmatite; at the contact between peg and skarn (and amphibolite)	Leptite, "Värmland granites"	Impregnations and veinlets	mo, cp	peg	I 3 A	Water-filled pit and dumps situated 6.5 km east of Lake Stora Ullen and 2 km SE of Gummhöjden	1917, and World War II	P (1917): Totally mined 630 tons, including 6 tons of hand-picked ore (G 6% Mo) and 130 tons of ore destinated for concentration. The dumps contain grey skarn-bearing leptite, dark-green amphibolite, and am-ep skarn. Veinlets of light-red am-bearing peg appear in leptite and amphibolite. Three small pits are located about 500 m NNE of Brännmossgruvan. The dumps show ma and skarn-bearing leptite and quartzite with gar-am and mi-skarn, Q-veinlets, and sparse pyrr-cp-ga mineralization.	Tegengren 1924, p. 65, 214	N
BLACKFÄRUS-GRUVORNA	ÖREBRO Lerbäck	Fe Mo	X			Iron ore	Leptite, skarn, Fe-ore, peg	Sparse impregnation	ma mo py, pyrr		I 3 B	Iron ore mines located between lake Skeppsjön and lake Bresjön, approximately 9 km north of Godegård	Drilling carried out in 1908	Traces of mo have been observed in iron ore with Fe-sulphides. Two samples taken from the dumps showed 0.27 and 0.45% MoS_2. The dumps contain Fe-ore and skarn (pyr, act, hor, mi, gar, epi, c) with peg veinlets, and partly gneissose leptite	AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH	N
DISTORPS-GRUVAN	ÖRELBRO Snavlunda	Fe Mo	X			Iron ore with skarn and peg	Redgrey leptite, mi-schist, iron ore, granite, peg, Q-veins.	Sparse impregnation	ma mo, Fe-sulphides		I 3 B	Several workings (pits and dumps) situated about 10 km north of Askersund		Mineralization probably connected with pegmatites. An analysis of poor iron ore (with Fe-sulphides) from the southwestern part of the mine area held 0.27% MoS_2.	AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH Geijer & Magnusson 1944, p. 564	N
BJÖRSTORPS-GRUVAN	ÖREBRO Snavlunda	Mo	X			Redgrey genissose granite, peg, apl, quartz veins	Oldest granites	Sparse impregnation	mo, py, cp		I 4	Two water-filled pits (8 m deep) and dump, located 11 km NNE of Askersund	1879 1917	Sulphide mineralization (limited extension) undoubtedly due to pegmatites	Tegengren 1924, p. 233	N
LEKHYTTAN	ÖREBRO Kvistbo	W	X			Limestone and dolomite (with skarn minerals)	Svecofenn. acid volcanics and sediments, younger Archean granite, peg	Spots (a few mm across) and veinlets in the central part of a carbonate layer	Sche		I 3 A (I 5 G)	Situated 2.3 km SW of Lekhyttan, near the track passing from E of Gubbatorp to the watch tower on Kunghallar	1959	Sche appears intermittently in a limestone-dolomite layer (length 400 m) bordered by red gneissose granite. Apparent width of the zone with concentrated mineralization: about 2.5 m, measured perpendicular to the strike of the carbonate rocks.	AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH (reports by T. Eriksson and B. Collini)	U(N)
KÄLLGRUVAN	ÖREBRO Nora	(Fe?), Mo	X			"bi - skarn"	Leptite, mica-schist, Fe-ore	Impregnation	mo		I 3 B (?)	Located east of Kortfors railway station	1915	P: 20 tons of hand-picked ore with 2-3% Mo (old dumps). Probably identical with SNÖBERGSTORPS Fe-ore mines	Tegengren 1924, p. 233	N
DALKARLSBERG	ÖREBRO	Fe W	X		X	Skarn ?	Leptite, iron ore, skarn		sche			Abandoned iron ore mines situated approx. 12 km SW of Nora		Övre Storrymningen, Kringlan, Djupgruvan	Lindroth 1922	U(N)
KÄPPSTABERGET	ÖREBRO Nora	Mo, Cu	X			Skarn	Leptite and hälleflinta	Sparse impregnations	mo, cp	Q	I 3 A (I 5 F)	Underground storage room located 700 m WSW of Gyttorp railway station	Discovered 1939 1940	The area is dominated by a northeasterly trending leptite complex with thin skarn layers. The dump originating from the excavation of the storage room contains grey, white, and light red leptite with skarn minerals and Q-veinlets, and massive dark green skarn. Traces of cp and mo have been observed in act-skarn. Magnetic survey carried out by H. Bergstrom, JOHNSON GROUP.	A. JOHNSON & Co., (correspondence 1942 and 1947)	N

Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned Prospect	Abandoned mine	Host rock	Country rock	Ore mineralization		Gangue	Type of deposit	Mine workings, location	Developed during	Comments	References	Importance of occurrence
ÖSTRA GYTTORP	ÖREBRO Nora	Fe, Ce, Mo, Cu	X		X	Quartz lenses and veinlets	Leptite, leptite gneiss, mi-schist, quartzite, metabasite	Sparse impregnations	ma or mo, py, cp	Q,hor,bi	I 2 (- I 3 A)	Abandoned Fe-ore mine and Ce-mine situated 4.5 Km WSW of Nora town and 1700 m NNE of Gyttorp railway station. Shaft (water-filled) and dump	1890-1893	Lense of fine-grained ma-ore surrounded by hor-chl skarn, bordered by grey leptite. Orthite lenses of relatively high purity (accompanied by Q-lenses with mo, py, cp, hor, and bi) have been encountered both in leptite and in skarn, mainly below the Fe-ore body. About 100 tons of ce-ore with an average grade of 20-25% cerium oxide have been produced. The deposit is mined to a depth of about 40 m. Little is left of the dumps, the rest containing dark green skarn with ma, skarn-bearing grey leptite with Fe-sulphides, mi-skarn, Q with traces of mo.	Tegengren 1924, p. 262	N
ASTONGRUVAN	ÖREBRO Guldsmedshyttan	Mo	X			Skarn, hälleflinta	Leptite, lst. and skarn	Impregnations	mo	Q	I 3 A (I 5 F,G)	Located about 800 m south of Lejagruvorna, east of Lake Usken	Probably during World War I, and 1965	8 test pits and two trenches within an area 100 x 100 metres. NORTHERN PART: 5 pits. The dumps contain pyr-am skarn, red leptite with skarn layers, and light red hälleflinta with a few Q-veinlets; mo appears in the form of impregnations in skarn, hälleflinta, and at the contact between both. The dumps originating from the 3 test pits in the SOUTHERN PART show skarn with Q-veinlets, coarse leptite with magnetite grains, and skarn-bearing ma-ore.	Occurrence obviously identical with "Lejagruvans molybdenförekomst", mentioned by Tegengren (1924, p. 233) A. JOHNSON & Co., (correspondence 1942, 1952, 1953).	U(N)
LEJAGRUVORNA (LEIJELGRUVAN, NYA GRUVAN, KITTELGRUVAN, BJÖRNKÄRR-GRUVAN)	ÖREBRO Guldsmedshyttan	Cu, Mo	X		X	Quartz veins	Leptite, limestone and skarn	Impregnations	cp,py,pyrr,mal mo	Q	I 3 A	Abandoned copper mines situated approximately 5 Km SSW of Guldsmedshyttan village	Worked intermittently 16th to 19th century, in 1906, and 1914-1919	6 workings and dumps; ore mined to a depth of about 60 m (mainly mineralized skarn). A limestone sheet with northeasterly trend is located between Leijelgruvan and Nya Gruvan. Cp and Fe-sulphides appear in the form of impregnations in pyr-am skarn and in grey limestone. Sulphides and mal are also to be found between pyr prisms. The dumps contain green skarn (locally gar-bearing) with c in vugs, limestone, leptite with skarn minerals; quartz (veins):traces of py and mo. P (1914-1915): Totally 226 814 tons with an average grade of about 0.4% Cu.	Tegengren 1924, pp. 236-237	N
TAGNISTEGRUVAN (LEJAGRUVORNA)	ÖREBRO Guldsmedshyttan	Mo	X			Skarn, pegmatite, and at the contact between both	--------"--------	Sparse impregnation	mo	peg	I 3 A	-------"------- Pit and dump located 160 m east of Leijelgruvan	Probably during World War I	The dumps show pyr-am skarn with c and peg veinlets.	--------- " ---------	N
GUSTAVSBERGS-GRUVAN	ÖREBRO Ramsberg	Fe Cu, W	X		X	Probably skarn	Leptite, quartzite, micaschist		ma py, cp, sche			Abandoned iron ore mine situated approx. 23 km NE of Lindesberg		W-mineralization seems to be of local character	Lindroth 1922 Geijer & Magnusson 1944, p. 302	N
RUNDBÖHÖJDEN (ROMBOHÖJDEN)	ÖREBRO Hjulsjö	Mo		X		In diorite, in peg, and at the contact between these rocks	Leptite, diorite, younger granite	Sparse impregnations	mo, py	peg	I 4	8 small testpits and trenches situated approx. 4 Km SW of Hjulsjo village and 200 m NE of "Vasteras" little farm	During World War II	Three small workings in the northern part of the prospected area are located in diorite with light red and grey pegmatitic veinlets. Sparse py and extremely poor mo-mineralization. The workings and outcrops in the south expose diorite, locally with peg or Q-veinlets, but without sulphide mineralization.	N. Zenzén, notes (1942) filed at AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH	N
MOLYBDENGRUVAN (KILLINGSBERGS-GRUVORNA)	ÖREBRO Hjulsjö	Fe, Mo		X	X	Chlorite-talc schist, limestone with skarn minerals and ma, act-skarn		Disseminations (normally flakes parallel with schistosity, but also veinlets cutting the chlorite-talc schist)	mo ma and hematite		I 5 G	Abandoned Fe-ore mine & Mo-prospect located 5 Km WNW of Hjulsjö village and about 1 Km south of Lake Ösjön	1917-1918 1942-1945	"KILLINGSBERGSGRUVAN" P (1917-1918): totally mined 915 tons; including 50 tons Fe-ore, 1 ton of Mo-ore with an average grade of 16% MoS_2, and 120 tons of Mo-ore which could not be concentrated by Uddgruvan dressing plant due to high content of talc and chlorite. MOLYBDENGRUVAN (located within claim Killingsberget): Shaft with 24 m depth, and a 40 m long drive cutting the mineralized chlorite-talc schist which is intercalated with skarn-bearing limestone and leptite. The width of the E-W trending schistlayer is 7 m, its length (cut by the drive) is 19 m; the mineralization seems to be concentrated to the foot-wall. One sample of ore (1.7 tons), taken from the shaft at -24 m, held 1.09% MoS_2. Another sample (4 tons), taken in the drive 10 m from the shaft, showed 0.57% MoS_2. The average grade of 30 tons of mineralized schist (hand-picked material, from shaft) was 0.64% MoS_2. Magnetic survey and core drilling carried out by JOHNSON GROUP. The dumps contain: Mainly chlorite-talc schist, grey and light red hälleflinta, act-skarn and asbestos in schist grey and light red limestone, skarn-bearing limestone with ma, dark green skarn with gar and ep. Grey hälleflinta also appears as intercalation in schistand is in many cases tectonized.	A. Johnson & Co, Dept. of Mines, Activity Reports years 1943-1945 N. Zenzén, Internal reports 1942 and 1944, filed at AXEL JOHNSON INSTIT. FOR INDUSTR. RESEARCH. Tegengren 1924, p. 65 & 233	N(-S)
SIRSJÖBERG	ÖREBRO Hällefors	Fe, Mo	X			Skarn	Hälleflinta, limestone, skarn	Sparse impregnation	ma mo			Iron ore mines situated about 14 km NNE of Grythyttan		Skarn minerals: pyr, amf (act, hor), gar, ep, c	A.Kåre (oral communication) Geijer & Magnusson 1944, pp. 220 - 223	N
KOPPARBERG	ÖREBRO Ljusnarsberg	Mo	X			Probably skarn	Leptite intruded by younger granite		mo					Tegengren reports test pits located immediately NW of Kopparberg railway station. Mo-mineralizations also to be found in the Ljusnarsberg and Kaveltorp mines	Tegengren 1924, p. 233	U(N)
ÄLGFALL	ÖREBRO Ljusnarsberg	W	X			Probably skarn	Leptite with peg veins, in the vicinity of granite massive (of Malingbo type)		Sche		I 3 A ?	Several claims located approx. 3.5 km ENE of Kopparberg, and 2.5 km southeast of "Viktorps-gruvan"			Dagens Nyheter (16.1.1967)	U(N)
VIKTORPSGRUVAN	ÖREBRO Ljusnarsberg	Mo	X			Skarn (mainly pyr skarn)	Leptite penetrated by Malingsbo granite	Sparse impregnation	mo, pyrr, cp		I 3 A	A few testpits about 3.1 Km NNE Kopparberg railway station	During World War I	A water-filled trench (3 x 8m) and a few minor pits are located 240 m SSW of Viktorp farm. The dumps show mainly pyr and am-skarn, and grey limestone with skarn minerals.		U (N)
STÅNGFALLSGRUVORNA (KUMMELÄLVSFÄLTET)	ÖREBRO Ljusnarsberg	Cu, Pb, Ag; Fe Mo	X	X		Garnet-bearing mica skarn, locally pegmatitic veinlets	Banded leptite, skarn, garnet-biotite schist and skarn	Irregular disseminations, locally rich mineralization	cp, ga, ma, az mo	Q, fs, c	I 3 A	About 10 workings and trenches, located approximately 3 Km WNW Ställdalen Village		The dumps contain mainly gar-bi schist, gar-bi-chl schist with cp and mo, gar-amf-mi and gar-bi-chl skarn with cp+mo+traces of ma, light red and grey-red leptite. Q and peg were observed in skarn. Another 5 workings are to be found south of the Stångfall mines. In the dumps green skarn and pink banded leptite were encountered. Veinlets of iron sulphides, traces of mal and mo appear in both rock types.	Magnusson 1940, p. 151	N
AXELGRUVAN (HÅNKABACKEN)	ÖREBRO Ljusnarsberg	Mo	X			Amphibolite	Malingsbo granite with remnants of leptite and limestone	Sparse impregnation	mo (also on slickensides)	fs, Q	I 3 A	Two trenches situated approximately 22 Km south of Ludvika, about 1 Km south of Lake Bredsjön		The workings are south of the N. Bredsjö-Korslångsvik road. An amphibolite sheet (width about 5 m) with intercalations of leptite is surrounded by red granite. Both amphibolite and granite contain pegmatite veinlets.	Magnusson 1940, p. 125	N
KORSLÅNGSVIK	ÖREBRO	Mo	X			Amphibolite	Late Svecofennian granite		mo			Located north of Kloten		Possibly identical with " Axelgruvan "	Tegengren 1924, p. 232	U (N)
STÄLLBERGS GÅRDS "JÄRNSKÄRP-NING"	ÖREBRO Ljusnarsberg	W	X				Leptite, older Archean granite		Sche			11 km south of Lake Yxsjön		Possibly located within Storhöjdsfältet	Lindroth 1922	U(N)
BLYBERG	ÖREBRO Ljusnarsberg	Fe, Pb, Ag, Cu Mo. W	X		X	Skarn, limestone	Leptite, skarn, limestone, micaschist, metabasite	Sparse impregnations	ma pyrr,ga,py,cp,sp,boul, bis mo, sche	fs,Q,c,fl	I 3 A	Ancient lead-silver, copper and iron ore mines located about 1.5 Km west of Ställberg railway station	Mainly during 17th and 18th century	Skarn minerals: pyr (hed, di), am (hor), gar, ep, zo, chl, phl, bi, fs Numerous pits, trenches, and shafts. Core drilling carried out during 1936, magnetic survey during 1938. Extremely poor Mo-mineralization was locally encountered in northern and southern part of mine area (BRATTGRUVAN). Samples of mo held 0.03-0.06% Re.	Hübner 1968 Magnusson 1940, pp. 90-91,152	N
GÖKGRUVAN (NORRA STÄLLBERGSFÄLTET)	ÖREBRO Ljusnarsberg	Cu, Mo	X			Skarn	Leptite, skarn	Sparse impregnation	mo, pyrr, cp		I 3 A	One pit and a trench on magnetic anomaly, situated 2.2 Km NNW of Ställberg railway station		Faint mo mineralization at the northern edge of eastern working reported. The dumps, investigated in 1965, contained only green skarn with traces of pyrr and cp, skarn with ma stringers, grey and light red leptite, and gar-bearing skarn.	Internal report, AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH	N

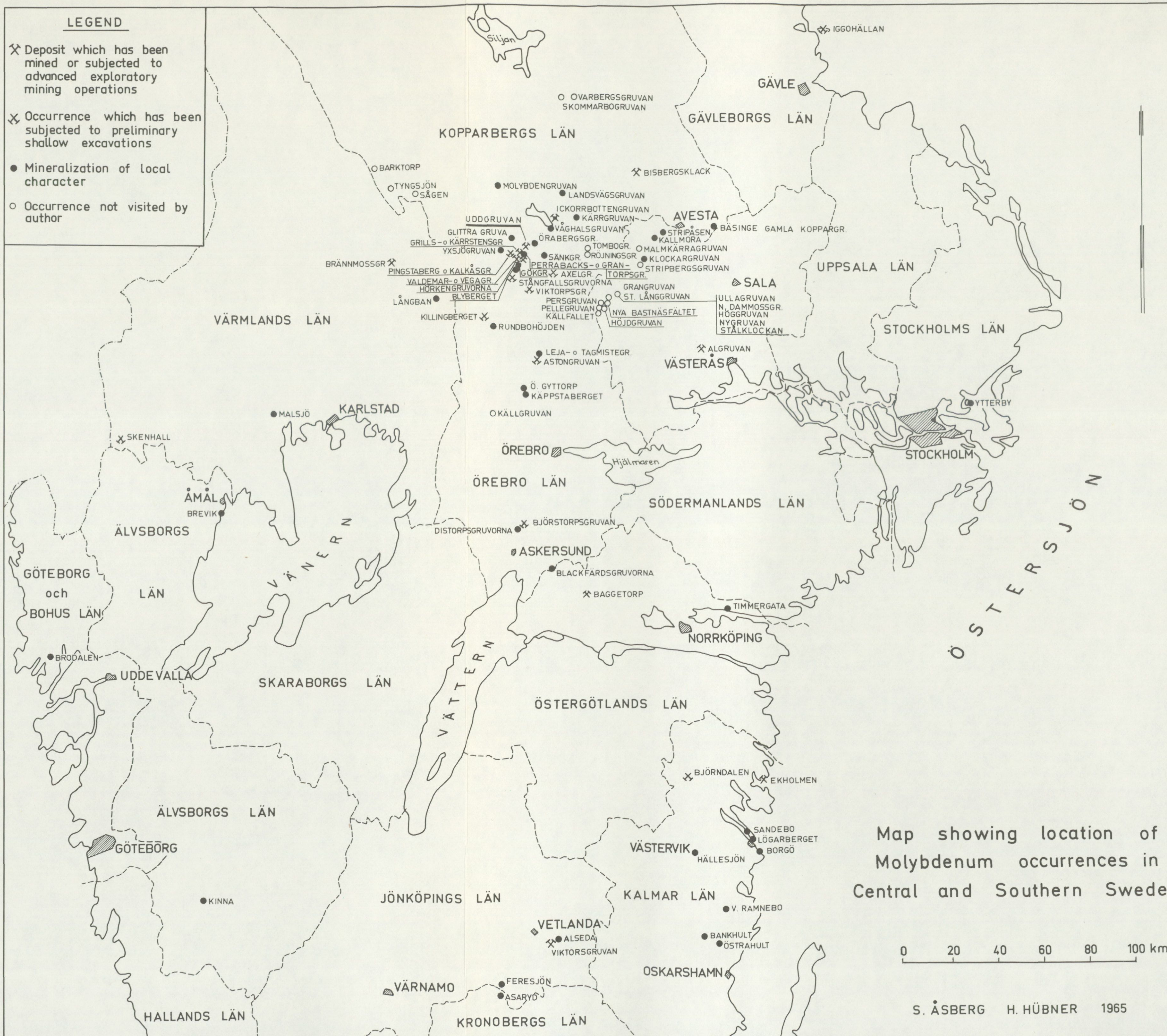
Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned Prospect	Abandoned mine	Host rock	Country rock	Ore mineralization		Gangue	Type of deposit	Mine workings, location	Developed during	Comments	References	Importance of occurrence
ÄLVGRUVAN (Järnvägsskärnings-malmen) HÖRKEN	ÖREBRO Ljusnarsberg	Mo, W		X		Skarn, pegmatite, quartz veins	Redgrey leptite, (locally granitized), granite, skarn with pegmatite, micaschist	Irregular dissemination	mo, sche	Q, fs (mcl), mi, fl, C	I 3 A	Shaft, dump, and two workings, located 1.3 Km SE Hörken railway station	Before and during World War II	By a drive on 30 m level connected with Silvergruvan. Several boreholes exist. P (Silvergruvan +Älvgruvan): Several hundreds of tons with about 1% MoS_2. G (average): 0.1% MoS_2, 0.08% WO_3.	Magnusson 1940, p. 16, 83, 90, 94-97, 100, 156-157 Magnusson 1953, pp. 318-320 Sorg 1919, pp. 35-43 Tegengren 1924, p. 232	N(-S)
SILVERGRUVAN (No. 1) HÖRKEN	------„------	Mo, W			X	Skarn, pegmatite, quartz veins, leptite, metabasite	Skarn and limestone with pegmatite and Q-veins, bordered by leptite; metabasite	-------„-------	mo, sche, pyrr ga, sp, cp, py	fs, Q, mi, fl	I 3 A	Shaft, drives on 30 m level, surface workings and dumps, situated about 1 Km SE of Hörken railway station	----„----	Skarnminerals: am (act, hor), pyr (hed, di), gar (gro), bi (phl), ep, ser. In the dumps also granite, aplite, and iron ore of sedimentary origin were observed.		
GRANTORPS-GRUVAN (HÖRKEN)	ÖREBRO Ljusnarsberg	Mo, W		X		Skarn, pegmatite	Grey leptite, skarn with pegmatite	Sparse impregnation	mo, sche	Q, fs, mi	I 3 A	2 small workings located about 1.6 Km ESE Hörken railway station		Skarn minerals: gar (gro), ep, am (hor), pyr (hed)	Magnusson 1940, pp. 155-156	N
PERRABACKEN (HÖRKEN)	ÖREBRO Ljusnarsberg	Cu, Fe, Mo		X		Pegmatite; mineralization also at contact between pegmatite and skarn	Grey leptite, quartzite, skarn with iron ore, biotite schist, pegmatite, quartz veins, metabasite	Sparse impregnation	ma pyrr, py, cp, ga, sp mo	Q, fs, bi, fl	I 3 A	6 workings and dumps about 1.4 Km east of Hörken railway station		Old Fe- and Cu-ore mines. Skarn minerals: am (act, hor), pyr, gar. Western part of mine area: Intensive pyrr and cp mineralization in skarn. Northern ------ " ------ : Biotite schist, and pegmatite with mo.	Magnusson 1940, p. 155 Tegengren 1924, p. 232	N
VEGAGRUVAN (Kvarnbacken, HÖRKEN)	ÖREBRO Ljusnarsberg	Mo, W			X	Skarn; mineralization also at contact between quartz veins and skarn	Grey leptite, skarn, limestone, iron ore, metabasite	Impregnations	mo, sche, pyrr, cp (in skarn); sp, ga (in limestone)	Q, C, fl	I 3 A	Shaft, several pits and trenches located 800 m SW of Hörken railway station	World War II	Skarn minerals: gar (gro), pyr (hed), ep, am (hor), sc 175 m north of Vegagruvan: Three pits and one trench with northerly direction (along strike). In the dumps and outcrops grey skarn-bearing limestone, green skarn, and grey leptite with skarn minerals were encountered. Sparse lead mineralization in limestone. In the dumps a few pieces of garnet-bearing skarn (without mo) have been observed .	Magnusson 1940, p.97, 98, 154 Tegengren 1924, p. 232	N(-S)
VALDEMARSGRUVAN (HÖRKEN)	ÖREBRO Ljusnarsberg	Mo, W			X	Skarn	Grey leptite, skarn, granite, pegmatite	Impregnations	mo, sche Fe-sulphides	Q, fs, fl	I 3 A	3 small workings and dumps about 1 Km WNW of Hörken railway station		A skarn lens (gar, ep, pyr, hor, Q) with limited extension has been mined to a depth of 10 m. Seems to be exhausted. P Totally mined: 438 tons, hand-picked ore: 30 tons (G 11% Mo) Ore for dressing: 30 tons	Magnusson 1940, p. 155 Tegengren 1924, p. 65, 232 Official Mine Statistics (year 1917)	N
KALKÅSGRUVAN (PINGSTABERG)	ÖREBRO Ljusnarsberg	Mo, W	X			Skarn with quartz veinlets	Leptite, limestone and skarn	Sparse impregnation	ma (small lenses in skarn) mo, sche	Q, C	I 3 A	Limestone quarry located about 3.3 Km west of Hörken railway station		Limestone body (length 40 m) surrounded by skarn "mantle." The limestone is white and coarse grained. mo and sche appear in skarn (gar, hor, pyr) cut by a trench northeast of the limestone quarry.	Magnusson 1940, p. 171	N
SOUTHERN PINGSTABERG AREA	ÖREBRO Ljusnarsberg	Mo, W		X		Medium- to fine-grained ("Malingsbo")granite	Granite intrusion in leptite	Irregular disseminations, local concentrations	mo, sche iron sulphides	fl	I 1	About 50 test pits and trenches situated approximately 3 Km WNW of Hörken railway station	1939 - 1940	Geochemical prospecting. Samples were taken with 20 m intervals along lines (distance between lines: 100 m). A few shafts have been sunk on anomalies, and core drilling has been carried out. Generally speaking the Mo-mineralizations are poor. However, local concentrations were encountered in granite near the contact with leptite to the west.	Prospecting carried out by Svenska Prospekterings AB (Internal report, Brundin & Palmqvist).	N(-S)
KÄRRSTENSGRUVAN (HÖRKEN)	ÖREBRO Ljusnarsberg	Mo, W		X		Skarn, iron ore	Grey leptite skarn with iron ore, limestone, pegmatite	Impregnations, local concentrations	mo, sche pyrr and cp in iron ore (ma) and skarn	Q, fs, C, fl	I 3 A,B	Shaft, trench and dumps, located 700 m NNW of Hörken railway station		Skarn minerals: pyr (hed), gar, am (hor), ep, mi (bi) Sche appears mainly at the contact between gar and pyr/am Locally rich impregnations, however, limited extension of mineralization.	Magnusson 1940, p. 98, 157	N
GRILLSGRUVAN (HÖRKEN)	ÖREBRO Ljusnarsberg	Mo, W		X		Skarn; mineralization also at contact between pegmatite and skarn	Grey leptite, skarn with pegmatite, quartz veins	Sparse impregnation	mo, sche, pyrr	Q, fs, mi, C	I 3 A	3 workings (3 x 3 m) about 1.4 Km north of Hörken railway station		Skarn minerals: Mainly gar and pyr (hed) Calcite vugs and veinlets.	Magnusson 1940, p. 157	N
Area between YXSJÖ and HÖRKEN	ÖREBRO Ljusnarsberg	Fe Mo, W, Cu	X X	X X	X	Characterized by numerous skarn occurrences	Leptite, limestone, skarn, amphibolite dykes, older and younger Archean granites, peg	Skarn occurrences with numerous local mo and/or sche mineralizations	ma pyrr, py, cp, sp mo, sche		I 3 A	The prospect area has the shape of a quadrangle, 7.5 by 7.5 km, covering i.a. the northern half of Lake N. Hörken	1948-1949	Starting east of the Yxsjöberg W-mines a magnetic reconnaissance survey was carried out in easterly and northerly direction covering the leptite terrain. The result of this magnetic survey did not show any distinct or regular pattern. Detailed investigations of some of the anomalies have been done, including TURAM survey.	Prospecting carried out by A. JOHNSON & Co., Dept. of Mines	N
												Hundtjärn area, situated about 4 km northeast of Yxsjöberg mines	1954	Initiated by discoveries of sulphide and sche mineralizations a completing TURAM survey has been carried out within this area, earlier investigated by magnetic reconnaissance. A conductive zone was determined and followed over about 2.5 km towards Lake N. Hörken. Also two magnetic anomalies on this lake have been covered by electromagnetic survey carried out on the ice. A sector with a well developed anomaly was finally tested by core drilling. The bore hole passes through a wheathered zone and red leptite. Analyses for Mn and Zn of the wheathered rock gave a negative result. The core did not show any sulphide or sche mineralization.	-----------„-----------	N
YXSJÖBERG N. Yxsjögruvan S. Yxsjögruvan Yxsjö Finngruvan Fridagruvan Åkergruvan Kvarnasgruvan Dammgruvan	ÖREBRO Ljusnarsberg	W, Cu, Mo, Fe			X	Skarn, Peg, amphibolite limestone	Leptite, limestone, skarn, amphibolitic dykes, peg	Impregnations, locally important concentrations	sche, pyrr, cp, py, wo (ferberite), mo, ma, bis (bismuth and bismuthinite), mal, az	skarn, peg fl	I 3 A	One modern and several ancient mines located south of Lake Yxsjön (12 km WSW of Grängesberg).	Discovered in the beginning of 18th century, intermittently worked since World War I, abandoned 1963 due to extremely low W-prices	Alternating sequence of leptite (probably representing metamorphic tuff) and limestone (at least 3 parallel layers, locally containing some iron ore) intruded by amphibolitic dykes. The whole complex has later been invaded by pegmatite, resulting in the formation of skarn, both in limestone and amphibolite. The pegmatites seem to be related to younger Archean granites of Malingsbo type. Peg minerals: perthitic mcl, albite-oligoclase to acidic andesine, Q, fl (often together with sche, locally important masses). Skarn: hedenbergite, grossularite-andradite, K-Fe amphibole, c (calcite, siderite), ep, bi, chl, apa, titanite, allophane (hisingerite). Deposit originally worked for copper ore. Scheelite discovered in 1862 by L. J. Igelström. First mining period of W-ore 1917-1920. (P: totally 10 184 tons including 7 016 tons of run-of-mine ore yielding 37 tons of concentrate). Production started again in 1935. P 1945: 126 000 tons of ore containing 248 tons of tungsten (also including some ore from Örabergsgruvan and Baggetorps mine) 1954: 127 213 tons of ore containing 274 tons of tungsten 1963: 92 183 tons of ore destinated for concentration. The average WO_3 grade is estimated at 0.3-0.4 percent. In 1969 the abandoned mine has been purchased by the Government Mining Company. Production supposed to start again in 1972 (new investments necessary estimated at 12 mill. Sw. Cr.). The Yxsjöberg occurrence represents the only W-deposit of importance in Sweden.	Lindroth 1922, 1924 Magnusson 1940, pp.165-171 Official Mine Statistics	S-M
YXSJÖBY GRUVOR	ÖREBRO Ljusnarsberg	Fe, Cu, Zn Mo, W	X			Gar-pyr-hor skarn	Leptite, limestone, skarn, mica schist, iron ore	Sparse impregnations	ma pyrr, py, cp, sp mo, sche	skarn	I 3 A	Several O.W. situated about 2 km NNE of Yxsjöberg mines		Iron ore with pyr and hor. The iron ore and limestone remnants locally show intensive sulphide mineralization (Cu, Zn).	Magnusson 1940, p. 171	N
MOSSTJÄRNGRUVAN	ÖREBRO Ljusnarsberg	Fe, W		X		Skarn	Leptite, amphibolitic dykes	Sparse impregnation	ma sche		I 3 A	Abandoned Fe-ore prospect, test pits located about 3 km NW of Yxsjöberg W-mines	1951	Iron ore with gar-pyr skarn; locally sche-bearing skarn has been observed in the dumps. After magnetic survey of the prospect two boreholes were sunk, passing through poor Fe-mineralizations, leptite and amphibolitic rocks. Only traces of sche were encountered in skarn.	A. JOHNSON & Co., Dept. of Mines	N

Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned Prospect	Abandoned mine	Host rock	Country rock	Ore mineralization		Gangue	Type of deposit	Mine workings, location	Developed during	Comments	References	Importance of occurrence
SÄNKGRUVAN (TENNBERGET)	KOPPARBERG Ludvika	W, Mo	X			Skarn, Fe-ore, and bordering granite	Malingsbo granite (Late Svecofennian fine- to medium-grained granite) with remnants of leptite and limestone	Sparse impregnation	mo (at contact between gar and green skarn) sche (in gar)	Q, c	I 3 A,B	Abandoned limestone quarry about 8 Km east of Silverhöjden, near the top of Tennberget		An about 20 m thick limestone body (greenish-grey medium grained lst. with skarn minerals) in red granite has been mined. At the contact between limestone and granite a 1-2 m thick mantle consisting of gar-bearing skarn with Q-veinlets is to be found. West of the quarry grey recrystallized chert (hälleflinta), and at its southwestern edge an outcrop of leptite was encountered.	Sorg 1919, pp. 35-43 Tegengren 1924, p. 204	N
UDDGRUVAN (VALBORGSGRUVAN)	KOPPARBERG	Mo, Cu			X	Quartz pegmatite (95% Q), locally showing cataclastic structures	Red porphyritic leptite conformably cut by tectonic zone (intruded by quartz pegmatite)	Relat. rich impregnations, locally mo concentrations (aggregates with up to several tens of Kgs)	mo, py, cp	Q (low temp. modification) mcl, chl, apa, ti, bitumen in Q geodes	I 2	Water-filled pit (length approx. 25 m), ruins of a flotation plant, and several dumps, situated about 3 Km south of Grängesberg Village	1887 1892 - 1893 1914 - 1920	Developed by shaft and 4 levels; deposit mined to about 60 m depth. In the dumps mo was also observed as impregnation in reddish-grey banded leptite, in skarn, and on slickensides in quartz. G (run-of-mine ore): 0.6 - 1.2 MoS_2. P (1887-1920): Totally mined 17 500 tons, hand-picked ore 37,6 tons, flotation concentrate 156 tons. The production of MoS_2 is estimated at about 130 tons.	Johansson, H.E., 1910, p.365 Magnusson, 1940, p.176; 1953, p. 320. Orton 1918, pp. 133-134 Sorg 1919, pp. 34-43 Tegengren 1924, pp. 230-232	S
"ÖRABERG SOUTH"	KOPPARBERG Grängesberg	Mo	X			Garnet-epidote skarn	Leptite with limestone and skarn intercalations	Sparse impregnation	mo (skarn) py (limestone)	Q, c, fl	I 3 A	Shaft (water filled), trench and dump located approx. 1.8 Km ESE of Grängesberg railway station		Workings located 150 metres northwest of southern end of Lake Örabergsdammen. The shaft is sunk in gar-ep-hor skarn and grey limestone. The limestone-skarn layer is bordered by grey to reddish-grey banded leptite and recrystallized chert (hälleflinta)	Probably identical with STENGRUVAN; cf. Tegengren 1924, p. 204	U (N)
ÖRABERGSGRUVAN	KOPPARBERG Grängesberg	W, Mo			X	Garnet-bearing and skarn-banded leptite, pegmatite	-------- " --------	Impregnations	sche, mo, py	Q,mcl,c,fl	I 3 A	Shaft, ruins of dressing plant and dumps, situated 1.6 Km east of Grängesberg railway station	During World War II	An outcrop south of the mine shows limestone with skarn intercalations, and massive skarn. The shaft is sunk in green skarn, intercalated with banded recrystallized chert. The whole complex is interwoven by pegmatite. The dumps contain: grey, light-grey and white (skarn-)banded leptite and recrystallized chert; garnet-bearing skarn with Q, c, py, violet fl, and sche; hor-skarn, act-mi skarn, bi-schist, and grey limestone with skarn minerals.		S
HÄSTTJÄRN	KOPPARBERG Grangärde	W, Mo	X			Amphibolite (Skarn ?)	Leptite	Sparse impregnation	pyrr, py, sche, mo	Q	I 3 A	O.W. situated 100 m east of Lake Hästtjärn (about 13.5 km west of Grängesberg)		Small E-W trending working in pyrr-py bearing amphibolite. Q, sche, and traces of mo are bound to a breccia. The W-Mo mineralization seems to be extremely poor		U(N)
GLITTRAGRUVAN (BJURUDDSGRUVORNA)	KOPPARBERG	Fe, Cu, Mo	X			Pegmatite veins in iron ore	Coarse grained red-grey leptite, granite, pegmatite	Sparse impregnation	ma, mar iron sulphides, cp, mal, cov mo	Q, fs, fl, or	I 3 A	O.W. (shaft, pits, and dumps) about 8.4 Km NNW of Hörken railway station		Iron ore with skarn minerals (pyr, hor, mi, chl, gar, ep, ser) sulphide veinlets, Q- and C-veins, and Mn-mineralization. One working in garnet-bearing skarn with pegmatite is to be found in the northeastern part of the mine area.	Magnusson 1940, p. 173 Tegengren 1924, p. 233	N
TOMBOGRUVAN RÖJNINGSGRUVAN	KOPPARBERG Söderbarke	Fe Mo	X		X	Iron ore, skarn	Leptite, skarn, iron ore, Late Svecofennian granite, peg	Impregnations	ma mo, py		I 3 B	Abandoned Fe-ore mines located about 16 km SE of Ludvika		Skarn iron ore (gar, pyr, act)	Geijer & Magnusson 1944 p. 385 Lundqvist & Hjelmqvist 1937 p. 55	N
BJÖRSBO (BJÖRBO)	KOPPARBERG Söderbarke	Mo	X												Högbom & Lundgvist 1930 p.66	U
SMEDJEBACKEN AREA	KOPPARBERG	W	X				Leptite, skarn, iron ore, older Archean granite		Sche				1954	Numerous dumps of abandoned prospects and mines have been investigated by means of UV-lamp. The most promising indication of W-mineralization was found at Tvåmansgruvan, 1 km south of Flatenbergs hytta	A. JOHNSON & Co., Dept. of Mines	U(N)
AREA EAST OF LUDVIKA	KOPPARBERG Norrbärke	Fe W	X		X	Skarn ?	Leptite, iron ore, skarn, older Archean granite		sche			Area located about 8 km east of Ludvika (iron ore occurrences)		Röberget, Rökärr, Kärrgruvorna	Lindroth 1922 Lundqvist & Hjelmqvist, 1937, p. 53	U(N)
VÅGHALSGRUVAN	KOPPARBERG Ludvika	Fe, Mo (?)	X			Skarn (iron ore)	Leptite	Sparse impregnation	mo		I 3 B	Abandoned iron ore mine about 2.3 Km WSW Ludvika railway station		Mo-mineralization in pyroxene skarn reported by Rechenberg (1960). In 1965 no molybdenite was encountered in the dumps.	Rechenberg 1960, p. 92	U (N)
ICKORRBOTTEN (HÖGBOTTEN)	KOPPARBERG Ludvika	Fe, Mo W	X		X	Fe-ore Skarn	Leptite, micaschist	Dissemination	mo (in magnetite; skarn) sche (in skarn) bor, other sulphides	fl	I 3 B	Big Fe-ore quarry and underground workings about 2.5 Km WSW of Ludvika	1918	1172 tons of iron ore yielded 661 tons of magnetite concentrate and 3216 Kg of molybdenite concentrate with 40% Mo. The molybdenum-bearing part of the iron ore has obviously already been mined. In 1965 scheelite has been observed in amphibole skarn.	Geijer & Magnusson 1944, pp. 347-348 Hjelmqvist 1966, p. 191 Tegengren 1924, p. 204	N
RAPPGRUVAN ÅKERGRUVAN	KOPPARBERG Grangärde	W		X		Skarn	Leptite, amphibolites, younger Archean granite, pegmatite	Impregnations	sche		I 3 A	Prospect situated in the vicinity of Gänsberget village, approx. 2 km east of Lake Gänsen (about 27 km NW of Ludvika)	1946	Trenches and test pits were dug in the Rappgruvan area. Also a magnetic survey was carried out. At Åkergruvan, within the Rappgruvan claim, sche-impregnations covering several tens of sq.m were discovered. Picked specimen contained up to 6.5% WO_3, the average WO_3 grade of the whole skarn body, however, does not seem to exceed 0.2 percent	A. JOHNSON & Co., Dept. of Mines	N
DALKARLBERGSGRUVAN	KOPPARBERG Grangärde	W	X			Skarn	---------- " ----------	Locally rich impregnations	sche	Q	I 3 A	Claim about 1.5 km west of above mentioned prospect. O.W. and dumps		Mineralization in gar-bearing skarn with Q, bordered by gneissose leptite. South of the claim sche has been encountered in gneiss with skarn minerals		U(N)
GÄNSBERGET	KOPPARBERG Grangärde	W		X		Skarn	---------- " ----------	Locally rich impregnations	sche, pyrr, py		I 3 A	Prospect located 100 m east of Jan Mats farm	1947 1948 1950	Trenches on magnetic anomaly. Seven boreholes totalling 284 m were drilled. Six of them cut sche impregnations. A shaft was sunk (incl. 32 m of drives on the 12 m level). 6 boreholes drillied from 12 m level. The investigations showed that a 40 m long northerly trending magnetic anomaly is due to a body of hed-hor skarn. Sche impregnations, frequently accompanied by pyrr, appear mainly within an area covering 10 x 30 m. The mineralized zone seems to have its maximum width on the 12 m level and pinches out about 25 m below the surface. G : Estimated at 0.19% WO_3	A. JOHNSON & Co., Dept. of Mines	N(-S)
LAFALLSGRUVAN	KOPPARBERG Grangärde	W		X		Skarn	---------- " ----------	Local impregnations	pyrr, py, sche		I 3 A	Approx. 2.5 km NW of Jan Mats (above mentioned locality) a big erratic block mainly consisting of skarn with pyrr, py, and sche has been found	1949	At the indicated locality a detailed magnetic survey in easterly and northeasterly direction has been carried out, also covering Lafallsgruvan (abandoned Fe-ore mine) situated 1.2 km NE of the erratic block with sulphide and W-mineralization. Trenches dug on magnetic anomalies north of this block did not strip any W-mineralization. At Lafallsgruvan and on a magnetic anomaly about 500 m south of it three boreholes were sunk, partly passing through hed-skarn, locally showing traces of sche	A. JOHNSON & Co., Dept. of Mines	N
SÅGEN	KOPPARBERG Ekshärad	Mo	X			Granite	Gothian granite		mo			Located W of Sågen			Hjelmqvist 1966, p. 191	U(N)
TYNGSJÖN	KOPPARBERG	Mo	X			Granite	------ " ------		mo, py		I 1 (?)	North and west of Lake Tyngsjön			---------- " ----------	U(N)
BARKTORP	KOPPARBERG	Mo	X			Granite	------ " ------	Irregular impregnations (mo in the form of flakes, up to 5 cm in size)	mo, py, cp	fl		SW of Kviensjöarna			---------- " ----------	U(N)

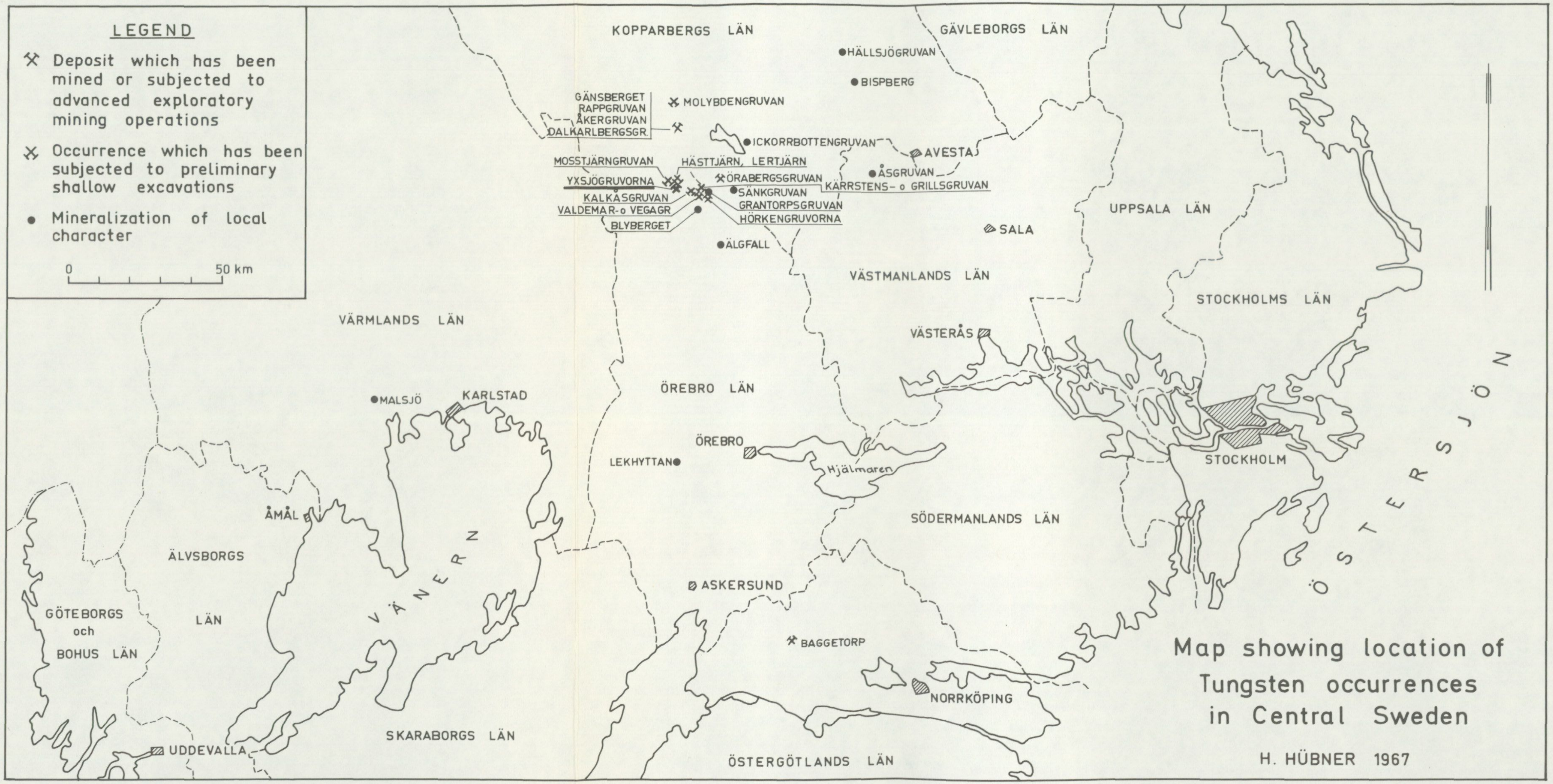
Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned Prospect	Abandoned mine	Host rock	Country rock	Ore mineralization		Gangue	Type of deposit	Mine workings, location	Developed during	Comments	References	Importance of occurrence
MOLYBDENGRUVAN	KOPPARBERG Grangärde	Mo, W, Cu		X		Skarn	Leptite, skarn lenses pegmatite	Sparse impregnations	pyrr, py, cp mo, sche	Q	I 3 A	2 pits (water filled) and dumps, situated approximately 11 Km W of Nyhammar railw.station	Probably during World War II	Claim located about 1.2 Km north Skäddartjärn, east of Lake Gensen. The dumps contain garnet-bearing green skarn with pyrr, py, some cp, and sche; massive gar-skarn; grey leptite, locally with skarn minerals; white hälleflinta with skarn. Veins of grey peg are to be found both in skarn and in leptite. mo appears locally in gar-bearing green skarn and in massive gar-skarn with Q-impregnation.		N
BÄSINGE GAMLA KOPPARGRUVA	KOPPARBERG Folkärna	Cu, Co Mo	 X		X	Mica skarn and quartzite	Older granite, basic intrusions, leptite	Sparse impregnation	ma py, cp, pyrr mo		I 3 A (I 5 E,F)	About 20 pits and trenches, and dumps, located approximately 14 Km east of Avesta	Intermittently from 16th century to end of 19th century	Abandoned Cu-Co mine situated about 3 Km east of Bäsinge village, near the road to Ångermansbo. Several testpits have been sunk (end of the 19th century). The dumps contain grey and light red banded leptite; skarn with ma, py, cp, and pyrr; grey quartzite with Fe-sulphides; light red granite. mo appears locally (together with cp and pyrr) in mi-skarn and quartzite. One sample of mo held 0.02% Re. P: Totally about 100 tons of copper	A. JOHNSON & Co., Dept. of Mines, Activity Report 1955 Sandegren & Asklund 1946, pp. 43-44 Tegengren 1924, pp. 190-191	N
BISPBERG BISPBERGS KLACK (RÖDGRUVAN, KNALL-GRUVAN, SKOTTGRUVAN, KLACKGRUVAN)	KOPPARBERG Säter	Mo, Cu, W			X	Red and grey granite, pegmatite, aplite, Q-veins	Enkullen granite, dolerite dykes	Disseminations (mo also on slickensides)	mo, cp, py, sche, mol, bor, ga, bis	Q,fs,c,fl	I 1,2	Shaft, 2 pits (water-filled), several trenches, and dumps situated approximately 2 Km ESE Bispberg railway station	During World War II	The Bispberg massive is built up of so-called Enkullen granite, cut by northeasterly trending dolerite dykes. The workings are located about 200 m northeast of the watch-tower (= highest point). The dumps comprize mainly medium-grained red granite, red aplite, grey granite, and pegmatite. The red granite is locally pegmatitic, contains Q-veins and some calcite. Samples of molybdenite showed up to 0.03% Re. The radioactivity of both the granitic outcrops and the dumps is 0.02 mR/h. The average grade of the dumps is estimated at <0.1% MoS_2. mo mineralization seems to be richer in grey granite varieties (rich in quartz). P (1942-1944): totally mined 34 950 tons, including 21 495 tons of run-of-mine ore and 7000 tons of barren rock	Hjelmqvist 1966, p. 191 Lundqvist & Hjelmqvist 1941, pp. 58, 61-62 Magnusson 1953, p. 320	S
HÄLLSJÖGRUVAN	KOPPARBERG Vika	Fe Mo, W	 X		X	Q-veins gar-act-hor skarn	Leptite, skarn, iron ore, older Archean granites	Local impregnations	ma mo, sche	Q, c	I 3 A	3 km south of Vika Strand		Abandoned iron ore mine	Hübner 1966, p. 25	N
SKOMMARBOGRUVAN	KOPPARBERG Ål	Mo	X			In pegmatitic parts of granite	Late Svecofennian granite and peg, leptite, skarn,	Sparse impregnation	mo		I 1,2	Several pits (water-filled), trenches and dumps at the southeastern end of Lake Helgsjön. The pits are marked on topographic map sheet No. 97 (Falun) SE of Leksand	Discovered 1917	Mineralization in mu-bi granite reported by Tegengren, but not encountered in the vicinity of the mines. The DUMPS show: darkgreen skarn, a few samples also containing gar, ep, and ma; grey leptite with skarn layers; white quartz (veins) with garnet; grey limestone. Locally poor py and cp impregnations, and grey to light red peg-veins have been observed in skarn. In the northeastern part of the mine area, and SW of it, grey to light red medium to coarse-grained granite (partly of pegmatitic character) has been met with.	Hjelmqvist 1966, p. 191 Tegengren 1924, p. 204	N
VARBERGSGRUVAN	KOPPARBERG Ål	Mo	X			Peg			mo					Possibly identical with Vargbergsgruvan (cf. Tegengren 1924, p. 168) located 17 km WNW of Falun	Külling & Hjelmqvist 1948 p. 55	U(N)
STOCKHOLM AREA	STOCKHOLM	Mo	X			Peg-veinlets in gneiss and granite	Sediments altered to veined gneisses, older and younger granites	Local impregnations	mo		I 4 I 2			Local mo impregnations appear in gneiss and granite with peg veinlets about 200 m SSW of Naturhistoriska Riksmuseet (W of the road), Frescati. Reportedly mo was encountered in pegmatite, and in bordering Stockholm granite in excavation for underground storage room at Värtavagen Sundius also mentions sparse mo impregnations in pegmatite in the abandoned felspar mine Ytterby, Resarö island	 Sundius 1948, p. 52 Sundius 1948, p. 74	N N N
ALGRUVAN	VÄSTMANLAND Västerås	Mo			X	Granite, mi-schist	Sediments altered to veined gneisses, granite	Sparse impregnation	mo		I 1	Pit and several trenches about 3.5 Km NW of Lillhärad church, and 200 m SE Älgmossen little farm	1940-1945	Small ore dressing plant, later on used for concentration of graphite (imported from Finland). The central part of the mine area is dominated by medium-grained light red to grey granite, to the northeast bordered by grey gneiss with Q-veinlets. Near the pit (shallow shaft) sparse mo-disseminations were observed in granite containing a few Q-veinlets. mo locally also appears in mi-schist remnants in granite. The dumps show limited extension. The production was probably extremely small.	Stenberg, K., 1940, 1941: Internal Reports, A. JOHNSON & Co., Dept. of Mines	N
RIDDARHYTTAN IRON ORE DISTRICT	VÄSTMANLAND Skinnskatteberg	Fe Mo, Cu	 X		X	Mainly skarn	Leptite, cordierite-bearing micaschist	Impregnations	mo, cp, bor, bis, or (and other cerium-minerals)		I 3 B	Numerous abandoned iron ore mines		Höjdgruvan, Pellegruvan, Nya Bastnäsfaltet, Stålklockan, Persgruvan, St. Långgruvan, Grangruvan, Norra Dammossgruvan, Ullagruvan, Nygruvan, Höggruvan, Alderkärret	Geijer 1923, pp. 56, 80, 88 Geijer & Magnusson 1944, p. 386 ff Högbom & Lundqvist 1930, pp. 49, 53, 66	N
KÄLLFALLET (RIDDARHYTTEFÄLTET)	VÄSTMANLAND Skinnskatteberg	Fe Mo	 X		X	Fe-ore	co-mi schist, co-ant quartzite	Dissemination	ma, locally py mo (in ma-ore)	or	I 3 B	Iron ore deposit situated approximately 10 Km west of Skinnskatteberg village		ma-ore with ant, talc, bi, cor, and locally Q. mo has earlier been won by flotation of tailings originating from concentration of Fe-ore.	Geijer & Magnusson 1944, pp. 389-390 Magnusson 1953, p. 320.	N
SALA	VÄSTMANLAND Sala	Mo	X			Grey to red-grey granite	Sala granite, carbonate rocks	On slickensides	mo		I 1	Located 200 m ESE of the old water tower		Mineralization of local character, observed in 1965 (250 m east of highway No. 67)		N
ÖSTRA STRIPBERGSGRUVAN (MOLYBDENGRUVAN)	VÄSTMANLAND Fagersta	Fe Mo			X X	Fe-ore	Leptite, quartzite, mi-schist, skarn, pegmatite, Fe-ore	Impregnations	mo		I 3 B	Situated in the Västanfors mine area, about 23 Km SW of Avesta	During World War I	Q-rich magnetite ore, pegmatite. Mines to a depth of about 25 m. A part of the ore showing rich mo-impregnations has been concentrated by hand-picking.	Geijer & Magnusson 1944, p. 409 Tegengren 1924, p. 292	U(N)
KLOCKARGRUVAN	VÄSTMANLAND Fagersta	Mo	X			Skarn, Q-veins	--------"--------	Sparse impregnation	mo	Q	I 3 A	Pits (water-filled) and dumps situated within the Västanfors mine area about 20 Km SW of Avesta and 2.5 Km NE of Meling village		The claims Klockargruvan, Åsgruvan No. 4, and Fallgruvan are located 1.5 Km E of southern end of Lake Örtjärnen. Klockargruvan comprises one shaft with small dumps containing grey leptite, light grey mi-quartzite, act-skarn with pyrr and mo, ma bearing skarn with py, skarn-bearing ma-ore, grey to light red ralatively mu-rich peg, and mi-schist; mo has also been observed in Q-veins with bi and chl; fl appears locally in joints.		N
RUDGRUVAN (SEHLAFÄLTET)	VÄSTMANLAND Fagersta	Fe As, Mo	 X		X	amf - skarn	Leptite	Sparse impregnation	ma ars mo		I 3 A	Iron ore mines located about 2 km NW of Fagersta		Skarn minerals: amf (act), pyr (di), ep, gar	A. Kåre (oral communication) Geijer & Magnusson 1944, pp. 111-112	N
KLACKBERG	VÄSTMANLAND Norberg	Fe Mo	 X		X	Skarn, carbonate rock	Leptite, dolomite, limestone	Sparse Impregnation	ma mo		I 3 A (I 5 F)	Dolomite and iron ore deposits situated approximately 2 Km WNW of Norberg		mo has locally been observed in a drive between Klackberg and Kolningsberg	A. Kåre, oral communication	N
BONDGRUVAN	VÄSTMANLAND Norberg	Fe Cu, Mo	 X			Skarn, Fe-ore	Leptite, skarn, older granite'	Sparse Impregnation	Iron ore cp, py mo	fl	I 3 B	Iron ore deposit located 2.3 Km NE of Norberg		gar-fl skarn	Geijer 1936, p. 38, 88-89	N
KALLMORA SILVERGRUVA	VÄSTMANLAND Norberg	Pb, Ag, Cu, Mo	X			Quartz, skarn	Leptite, cor-mi schist, quartzite, limestone, skarn	Sparse impregnation	ma ga,cp,py,bor,ars,sp mo	fl, Q	I 3 A	Iron ore mines and abandoned Pb-Ag mine situated 5 Km NNE of Norberg		Kallmora Silvergruva comprizes 2 shafts, deepest level 193 m (Torvgruvorna). Pb ore appears close to sedimentary Fe-ore, or limestone and gar-skarn; also impregn. in quartzite or veinlets in leptite. mo bound to andradite-act skarn with fl, and massive Q.	Geijer 1936, p. 38, 111-112 Hjelmqvist 1946, p. 53	N
STRIPÅSEN	VÄSTMANLAND Norberg	Cu, Mo	X			Quartzite, skarn	Leptite, cor-mi schist, quartzite, skarn	Impregnation	cp, py, pyrr mo ma	fl, or	I 3 A (I 5 E,F)	Iron ore deposit and ancient Cu-mine located approx. 8 Km NE of Norberg and about 400 m N of Stripåsen railway station		Skarn minerals: gar (andradite, almandite); amf (ant, act) O. W. (depth 110 m)	Geijer 1936, p. 38, 120-123 Hjelmqvist 1946, p. 53	N

Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned Prospect	Abandoned mine	Host rock	Country rock	Ore mineralization		Gangue	Type of deposit	Mine workings, location	Developed during	Comments	References	Importance of occurrence
IGGÖHÄLLAN	GÄVLEBORG Hille (Gävlebukten)	Mo, Cu		X		Veined gneiss (bi-amf gneiss); at the contact between gneiss layers and pegmatitic veinlets, in the central part of peg veins, and in partly assimilated gneiss remnants penetrated by peg.	Sediments altered to veined gneiss	Impregnations	mo, py, cp	fs, Q, mi	I 4	Island (approx. 650 x 200 m) located 1 Km north of Iggön. About 20 test pits and trenches exist	1930-1944	The country rock consists of banded grey gneiss with layers of leptite, intercalated with basic (bi-amf) gneiss. The gneiss complex is cut and veined by pegmatite. Graded bedding has locally been preserved. mo appears in the form of impregnations in two zones, more or less parallel to the strike of the country rock. Max. thickness of northern zone: 35 m (length about 200 m) Max. thickness of southern zone: 15 m. Locally scarse impregnation of Fe-Cu sulphides has been encountered. SAMPLE (800 kg of crude ore taken from the dumps): 0.17 % MoS_2. Another sample from a test pit held 1.09% MoS_2 and 0.23% Cu. G(average): Probably less than 0.2% MoS_2	Internal reports by K. Mörtsell and S. Mörtsell, filed at AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH, Geoscience Dept. Lundegårdh 1967, p. 213	N(-S)
GARPMYRAN	GÄVLEBORG Hamra	Mo	X			peg, apl	"Rättan" granite	Scattered grains	mo, py, pyrr		I 2			peg and apl belonging to older post-orogenic granite with microcline augen (Rättan granite)	Th. Lundqvist 1968, p. 75	N
BUREÅ	VÄSTERBOTTEN	Mo, Cu	X			Gneiss rich in pegmatite	Veined gneiss (migmatite)	Impregnations	mo, cp			Situated about 20 km SE of Skellefteå		Mineralization near the water - tower, south of Bureå	Gavelin 1955, p, 76	N
BOLIDEN	VÄSTERBOTTEN	As, Au, Cu, Pb, Sb, Ag, Zn, Co, Ni, Se, Bi, Te, Ti, Sn, W, Mo	X		X	Quartz veins, unaltered rocks, altered rocks with sulphides, lamprophyre dykes	Acid volcanics and sedimentary rocks, altered	Mainly in the form of impregnations	Pyrr, ars, cp, py, sulphominerals, sche, mo ?	Q, in cases tourmaline, skarn minerals	I 5 A,C,D,E,G	Mines located about 30 km WNW of Skellefteå		Complex sulphide ores. Three different stages of ore formation: sche mineralization mainly related to 2nd stage (Q - tourmaline veins). Sche encountered in cores of 23 bore-holes and in stopes (western part of the eastern ore lens). Most abundatly in solid pyrr-ore. Grip mentiones WO_3 - grades between 0.4 % (width 3.4 m) and 2.7 % (width 4.5 m). Mo in subordinate amounts in sche-bearing rocks, rutile and apatite rocks (determind by spectrographic analysis)	Grip 1951, pp. 457-460 " Ödman 1941	N
LÅNGSELE	VÄSTERBOTTEN	Zn W	X			Sericite-quartzite ?	Volcanic and sedimentary rocks, weakly altered	Local impregnation	py, sp sche		I 5	Sulphide ore deposit situated approx. 6 km SW of Boliden		Solid pyrite - zinc ore	Grip 1951, p, 460	N
LÅNGDAL	VÄSTERBOTTEN	Zn, Pb Ag, Au, W	X			Skarn, Q - veins, sulphide ore, at the contact between metabasite and ore	Volcanic and sedimentary rocks, altered	Impregnations	py, sp, ga sche, pyrr	C	I 5 A,D,F	Sulphide ore deposit located about 8 km SW of Boliden		Solid pyrite - zinc ore and dissemination ore	Grip 1951, pp. 460 - 461	N
ÅKULLA	VÄSTERBOTTEN	Cu W	X			Q - veins and adjacent greenstone	Acidic volcanics (altered), greenstone dykes	Local Impregnation	py, cp sche	Q	I 5 C,D	Sulphide ore situated approximately 7 km NW of Boliden		Pyrite ore with small amounts of copper	Grip 1951, p. 461	N
KEDTRÄSK	VÄSTERBOTTEN	Cu, Zn W	X			Quartz and amphibolite	Volcanic and sedimentary rocks, intensely altered	Local Impregnations	py, sp, cp sche	Q	I 5 C(+ G)	Sulphide ore deposit located about 25 km WNW of Boliden		Solid pyrite ore with a small content of Cu and Zn	Grip 1951, pp. 461-462	N
ÅSEN	VÄSTERBOTTEN	Cu, Zn W	X			Skarn, and together with pyrr	Volcanic and sedimentary rocks, intensely altered	Sparse impregnations	py, cp, sp, pyrr sche		I 5 A,F	Series of ore bodies situated from 23 km to 29 km WNW of Boliden		Solid pyrite ore with some Cu and Zn. Average grade of the ore : less than 0.01 %W	Grip 1951, p. 462	N
RAKKEJAUR	VÄSTERBOTTEN	Cu, Zn Au, W	X			Sericite-quartzite or graphite-bearing phyllite	Volcanic and sedimentary rocks, weakly altered	Traces	py, cp, sp, ars sche		I 5	Located 65 km WNW of Boliden		Fine - grained pyrite with small amounts of Zn, locally also Cu; Mo detected by means of spectrographic analysis of average ore samples	Grip 1951, p. 462	N
KRISTINEBERG	VÄSTERBOTTEN	Cu, Zn W, Mo	X			Sericite and chlorite schist, pyrite ore, Q - tourmaline veins	Acid volcanics, intensely altered	Impregnations, also big lumps	py, cp, sp sche, mo	Q	I 5 A,B,C,E	Mine situated about 87 km WNW of Boliden		Pyrite ore with varying percentages of Cu and Zn; sche occurs close to the largest pyrite ore body, in the vicinity of Q - tourmaline veins. Samples of sericite schist with Q and sche showed between 0.34 and 0.48 %WO_3, and 0.000%Mo (three rich samples). Mo - content of scheelite in drill - cores varies between <0.05 % and 1.4 % (estimated by means of " Scheelite Fluorescence Analyzer "). Grip has presented three analyses of average samples: (% WO_3 / % Mo) 1. Pyrite ore, rich in Cu <0.001 / 0.0034; 2. Zinc ore <0.001 / 0.0008; 3. Pyrite ore <0.001 / 0.0013	Du Rietz 1951 Grip 1951, pp. 462-464	N
RÄVLIDEN	VÄSTERBOTTEN	Cu, Zn W	X			Q - veins, and "ore-quartzite"; also in chlorite schist and calcareous parts of the bed - rock	Sericite schist, phyllite	Impregnations, and lumps (several cm in diameter)	py, pyrr, cp, sp sche	Q	I 5 F	Several lenses of sulphide ore, located 4 km west of Kristineberg		Analysis of average samples of the ore : <0.01 %W	Grip 1951, p. 464	N
LAINIJAUR	VÄSTERBOTTEN	Ni, As W, Mo	X			Calcite and Q-veins representing apophyses of a very complex arsenic-nickel ore, in breccias with As - Ni ore, and in the wall rock close beneath	Gabbro - diorite, sediments of the phyllite series, Adak-type granite	In veins, breccias, and adjacent wall rock (mainly swarms); Rare spots, mainly as thin films at the contact between Ni-As ore veins and the wall rock	nickel - pyrrhotite, complex arsenic-nickel ore; sche; mo (1 sample analyzed held 0.25 % Re)	Q, C	I 5 A	Nickel deposit situated about 27 km NE of Kristineberg		The sche investigated showed a white - blue fluorescence colour indicating a Mo - content of 0.05 - 0.14 percent. Grade of average samples according to Grip: (% WO_3 / % Mo) Nickel - pyrrhotite ore 0.01 / <0.0001; Nickel - arsenic ore 0.01 / 0.0007	Grip 1951, p. 465	N
LINDSKÖLD (ADAKGRUVAN)	VÄSTERBOTTEN Malå	Cu, As, Pb, Mo, W	X			Quartz veinlets and skarn	Quartzite overlain by intermed. (mainly tuffaceous) sediments, granite (Lina-type)	Impregnations	cp, pyrr, py, ars ga, bis mo, sche	Q c	I 5 C,F	Copper mine situated approx. 22 km NNW of Malåträsk		mo appears locally in Q - veinlets and in Ca - silicates below the copper ore bodies, also in the hanging wall (in places rich mineralization in skarn)	Gavelin 1948, 1952 Grip 1951, pp. 465-466	N
KARLSSON ORE (ADAKGRUVAN)	VÄSTERBOTTEN Malå	Cu Mo	X			Q - schlieren	"		Fe - sulphides, cp mo	Q	I 5 C	Sulphide mineralization located about 400 m east of the Lindsköld mine			Grip 1951, p. 466	N
"N. JOHANNISBERG"	VÄSTERBOTTEN	Mo	X			Red aplite	Granite (Adak -Lina type)	Locally in joints	mo		I 2	One small trench located approx, 17 km west of Adak			Gavelin 1955, p. 76	N

Name of molybdenum/tungsten occurrence	PROVINCE District	Important metals	Indication	Abandoned Prospect	Abandoned mine	Host rock	Country rock	Ore mineralization		Gangue	Type of deposit	Mine workings, location	Developed during	Comments	References	Importance of occurrence
LAVER	NORRBOTTEN	Cu, As, Zn, Ni, Co, Ag, Mo, W	X			Liparite and skarn, Q-veins, greenstone dykes, mo mainly in the Cu -ore	Acid volcanic rocks (Arvidsjaur volcanics) greenstone and granite - porphyry dykes, peg and Q - veins	Impregnations	cp, pyrr, sp, ars mo, sche	Skarn Q, C	I 5 B,D	Copper deposit located approx. 90 km west of Luleå and 100 km north of Boliden		Sulphide mineralization in the form of replacement breccia and veins, partly bound to faults. Skarn minerals: gar,bi,chl. Veinlets with Ni, Co and Ag minerals represent a younger phase. According to Grip mo and sche are connected with the sulphide mineralization. 14 samples of ores and skarn analyzed showed 0.oo15 to 0.o3 % Mo, the W - content not exceeding 0.001 percent.	Du Rietz 1945 Ödman 1943, 1945, 1957 Grip 1951, pp. 466-467	N
NIMTEKJAURE	NORRBOTTEN Radnejaure	Cu, Mo	X			Porphyritic andesitic "basalt"	Andesitic "basalts" in the vicinity of the zone the rocks are schistose and commonly garnetiferous	Vertical zone of sulphide impregnation	cp, py, sp bor, mo, native copper, arsenopy		I 5 G	Situated 700 m north of Nimtekjaure		Geophysical prospecting and core drilling carried out by Swed. Geol. Survey.	Padget 1966, p. 54	U(N)
"ARDNAPOUDA" (Björntjärn)	NORRBOTTEN Arjeplog	Mo, Cu	X			At contact between granite and metamorphic sediments		Sparse impregnation	mo, cp			Located in the vicinity of Lövnäs		New prospect recently developed by Swed. Geol. Survey.		U
POKEHÄLLAN	NORRBOTTEN Jokkmokk	Mo	X			Pegmatite-aplite (with fragments of granite and amphibolite)	Red granite ("Lina granite"), pegmatite, gabbro	Sparse impregnation	mo py	Q	I 2	2 trenches situated south of Lilla Lule älv, approximately 27 Km SE of Jokkmokk village			Högbom 1931, p. 45	U(N)
MATTISUDDEN	NORRBOTTEN Jokkmokk	Mo	X			Pegmatite	Light-red gneissose leptite intruded by granite sills ("Lina granite")	Sparse impregnation	mo	mcl,Q,hor, bi, ma	I 2	Claim located on the slope of Lina mountain south of Mattisudden village (about 8 Km SE of Jokkmokk village)		mo appears in the form of isolated flakes or aggregates in peg (also in joints of hor and in bi-aggregates)	Högbom 1931, pp. 44-45	U(N)
JOKKMOKK	NORRBOTTEN Jokkmokk	Mo	X			Pegmatite	Gneissose acid volcanics, granite ("Porjus granite")	Sparse impregnations, local concentrations	mo (flakes and aggregates)	mcl perthite, Q,bi,ma	I 2	Mineralizations located about 800 m south of Jokkmokk church and on northwestern slope of Talvatesvare		Average grade low	Högbom 1931, p. 44	U(N)
DRUGGEGRUVAN (KLUBBUDDEN)	NORRBOTTEN Jokkmokk	Mo			X	Pegmatite, quartz	Two different types of granite (Porjus and Lina type)	Flaky aggregates and veinlets	mo, py	Q	I 2	Trenches at the northern end of Mt Vuodsåive (northwestern part of Lake Klubbuddsjön), approximately 18 Km NE of Jokkmokk	During World War II	Mt Vuodsåive is built up of red granite with pegmatite veins. Width of mineralized zone about 4 m. Mineralized area investigated by trenches: approx. 50 m². Continuation of zone to the southwest and northeast covered by overburden. One analysis gave 5.9% Mo, 1 g/t Au, <1 g/t Ag. P: 20 tons of hand-picked ore with an average grade of 0.48% Mo.	Högbom 1931, p. 44 Ödman 1957, p. 120	U (N-S)
VÄHÄVAARA	NORRBOTTEN	Mo, Cu		X		Pegmatite (contact with amphibolite)	Granite (Lina type) pegmatite, gneissose porphyrite belonging to Bälinge series	Impregnations	mo, bor ma	fs (oligoclase), mu	I 2	Situated about 40 Km ESE of Gällivare, on the eastern slope of Mt Vähävaara, east of Lina River	During World War I	mo appears in the form of small aggregates together with fs, mu, and bor within a restricted zone (only a few cm wide) at the contact between tourmaline-bearing pegmatite and amphibolite gneiss (to the southeast). The zone with mo-mineralization is bordered by a seam consisting of ma. P: without importance.	Geijer 1924, pp. 15-20 Tegengren 1924, p. 95 Ödman 1957, p. 120	U (N-S)
LIIKAVAARA ÖSTRA	NORRBOTTEN Gällivare	Cu W	X				Acid volcanics	Locally sparse impregnations	sche					Cu-ore		N
AITIK	NORRBOTTEN Gällivare	Cu Mo	X				Acid volcanics	Locally sparse impregnations	mo					Cu-ore		N
NUNISVAARA	NORRBOTTEN Gällivare	Mo		X		Pegmatite intruding gneissose leptite and gabbro	Gabbro, gneissose acid volcanics, Lina type granite	Impregnations	mo		I 2	South of Nunisvaaragården (south of Vasara River), approximately 5 Km east of Gällivare	Discovered 1953		Ödman 1957, p. 120	U(N)
ULTEVIS	NORRBOTTEN Jokkmokk	Fe, Mn W, Mo	X	X		Porphyry, lst., piedmontite rock, Q-veinlets, skarn-bearing greenstone, tuffite	Granite, volcanics, limestone, greenstone, felspathic quartzite	Disseminations, small lenses, coating in fissures	Manganese and iron minerals, molybdo-scheelite, tungsten-powellite	Q, C, ti, apa, fl	I 5 C,F,G	Area (about 25 km long, northeasterly striking zone) located 75 km northwest of Jokkmokk	1940-1947	Sedimentary and epigenetic Fe-Mn mineralizations. Molybdo-scheelite has been encountered at many places within the Ultevis district and occurs in the form of occassional grains throughout the whole stratigraphic sequence. The richest and largest concentration has been found in a local accumulation of glacial boulders, consisting mainly of piedmontite and some quartz. W-Mo mineralization (contemporary with the formation of piedmontite) probably due to hydrothermal solutions emanating from granite, or leached and mobilized from adjoining rocks contemporaueously with the manganese. Spectrographic analyses of various rock types showed grades of only < 0.008 % Mo and <0.005 % W. Magnetic and electrical prospection, trenching and core drilling carried out during several periods 1941 - 1945, covering about 33 sq. km	Ödman 1947, 1950 Grip 1951, p. 470	N
SÄRKIVAARA (SÄRKIROVA)	NORRBOTTEN	Mo, Cu	X			Skarn	Basic volcanics with sediments, intermed.-basic lavas	Impregnations (local concentrations)	cp, bo, cc mo		I 5 F (?)	Situated in the vicinity of Svappavaara		Skarn of the Särkivaara copper occurrence locally contains rich mo concentrations.	Ödman 1957, p. 121	U
ÄIJÄROVA	NORRBOTTEN	Mo, Cu	X			Pegmatite and bordering amphibolite	Granite (Lina type), basic volcanics with sediments	Local concentrations	mo, py	Q, sca	I 2	Located approximately 15 Km west of Vittangi (at the Svappavaara-Vittangi road)		Investigations carried out by Swed. Geol. Survey indicate that the mo-concentrations are of local character and do not persist to depth.	Ödman 1957, pp. 120-121	N



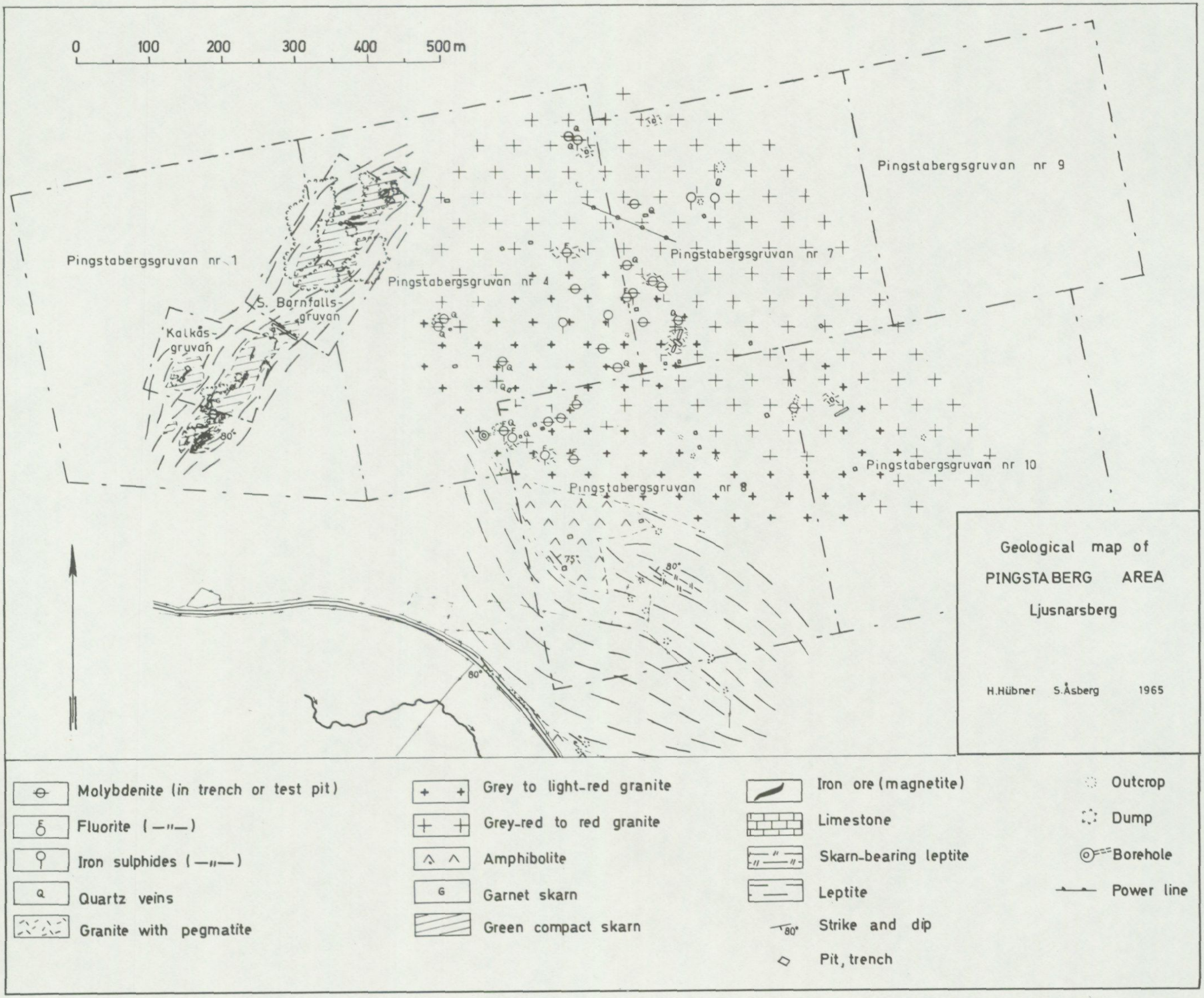
Map showing location of Molybdenum occurrences in Central and Southern Sweden

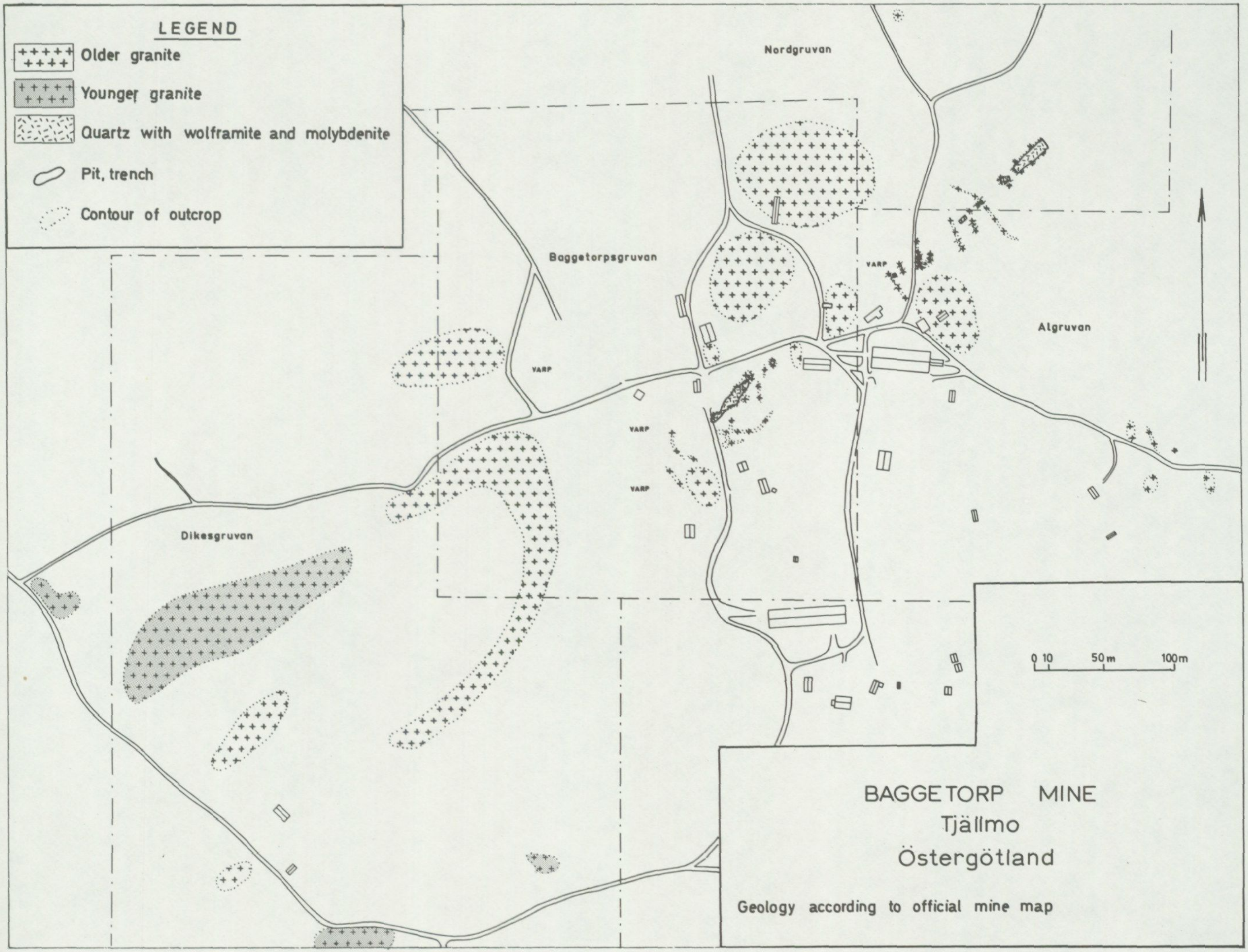


Map showing location of Tungsten occurrences in Central Sweden

H. HÜBNER 1967

Plate XI


0 100 200 300 400 500 m
Pingstabergsgruvan nr 1
Pingstabergsgruvan nr 4
Pingstabergsgruvan nr 7
Pingstabergsgruvan nr 8
Pingstabergsgruvan nr 9
Pingstabergsgruvan nr 10
S. Bornfalls-gruvan
Kalkås-gruvan
Geological map of
PINGSTABERG AREA
Ljusnarsberg
H. Hübner S. Åsberg 1965
Molybdenite (in trench or test pit)
Fluorite (—"—)
Iron sulphides (—"—)
Quartz veins
Granite with pegmatite
Grey to light-red granite
Grey-red to red granite
Amphibolite
Garnet skarn
Green compact skarn
Iron ore (magnetite)
Limestone
Skarn-bearing leptite
Leptite
Strike and dip
Pit, trench
Outcrop
Dump
Borehole
Power line


LEGEND
Older granite
Younger granite
Quartz with wolframite and molybdenite
Pit, trench
Contour of outcrop
Nordgruvan
Baggetorpsgruvan
VARP
VARP
VARP
VARP
Algruvan
Dikesgruvan
0 10 50 m 100 m
BAGGETORP MINE
Tjällmo
Östergötland
Geology according to official mine map

PRISKLASS G

C DAVIDSONS BOKTRYCKERI AB, VÄXJÖ 1972