Reserves and resources of ores and fluorite/barite in Saxony

(= detailed version of LEHMANN (2010): Reserves and resources of ores and fluorite/barite in Saxony. – World of Mining – Surface & Underground, 62, 1/2010, 38-47, GDMB Informationsgesellschaft mbH; in february 2011 actualized/supplemented)

Abstract

Between 2006 – 2008 tangible geological and economical data of the most important occurrences and deposits of ores and fluorite/barite in Saxony were compiled. For the 139 occurrences and deposits included in this data base reserves and resources of 31 elements and industrial minerals are reported based on the categorisation used in the former German Democratic Republic. This resource resp. reserve categories are based on standards that may be still used today to assess the validity of the data. The significance of this classification under market economic conditions needs to be critically reassessed. Such a reassessment may result in significant increases or reductions of reserve/resource figures. The data base illustrates the availability of large reserves/resources in known deposit districts with significant brown fields exploration potential. This renders medium-term reactivation of the metal and industrial mineral mining industry in Saxony likely.

1. Project ROHSA

Funded by the Saxonian Ministry of Economy and Labour in the period from 2006 – 2008 the Geokompetenzzentrum Freiberg e.V. (GKZ) compiled available data on the most important occurrences and deposits of metal as well as industrial minerals (fluorite, barite) in Saxony. Using the acronym ROHSA (Rohstoffe Sachsen) it was the aim of this exercise to critically reassess the known resources/reserves for market economic conditions. Data were sourced mostly from the geological archives of the State Office of Environment, Agriculture and Geology (LfULG) of Saxony as well as the WISMUT GmbH and several other institutions. Geological and other tangible parameters (infrastructure, processability etc.) were captured in a database. Because of the duty to observe confidentiality, the data base as a whole is not available to the public. A simplified schematic overview (referred to as „Steckbriefkatalog") is, however, available for download at the internet address http://www.umwelt.sachsen.de/umwelt/download/geologie/Katalog_Neubewertung_Erze_Spate.pdf. Five occurrences/deposits of particular significance (tin/tungsten Pöhla-Globenstein, fluorite/barite Schönbrunn-Bösenbrunn, tin Gottesberg, tungsten Delitzsch, barite Brunndöbra) were described in more detail („Steckbriefe"). Geological descriptions are supplemented by summaries of global prices and production data of selected commodities as well as of available extraction and mineral processing methods (GKZ, 2008).

2. Classification of mineral reserves/resources

The grading of reserves and resources in the former German Democratic Republic (G.D.R.) was based on a legal framework for the classification of reserves/resources of mineral raw materials that was introduced in 1956 – with subsequent updates (SLABY & WILKE, 2005). Within this framework instructions and guidelines were published for selected raw materials (BOCHMANN, 1979). The classification distinguished „proven" (A-, B-, C_1- and C_2) reserves from "probable" (not yet verified, prognostic) resources (D_1 and D_2). Fundamental to this classification were the level of exploration (kind and extent of exploration data available) and geological understanding (level of interpretation of data).

Proven reserves were marked as assets ("Bilanzvorräte" in capital letters: A, B etc.), if they matched the national economic demands („conditions") and were suitable for exploitation. If they did not match the conditions, they became marked as non assets ("Außerbilanzvorräte" with lower case letters: c_2, c_1, until 1979 also a and b).

Instructions specifying exactly the requirements that had to be met for different grades existed for example for fluorite and barite, copper, lead-zinc as well as iron deposits. It is necessary to stress that updates of these instructions were released from time to time; assessment of any reserve calculation, therefore, requires careful consideration of directives valid at the publication date.
The term „perspective masses“ (shortened: pM), that was applied mostly to fluorite/barite (spars) occurrences, corresponded to the term prognostic resources regarding the degree of investigation. However, for these resources sufficient data were not available to determine the technology and cost of extraction and processing (TISCHENDORF ET AL. 1980).
In cases in which reserves/resources are in the source documents not defined any more precise than “confirmed” or “probable”, they will be denoted in this paper as „C“ or „D“. In absence of any accurate classification the term „other resource“ is choosen.
Ore deposits are parts of geological occurrences of raw materials that permit commercial exploitation by means of quantity and quality of the contained resource (SLABY & WILKE, 2005). However, since ores and spars have not been exploited in Saxony since 1991 and since no bankable feasibility studies have been concluded with positive results in this period of time, the use of the term occurrence - rather than deposit – will be used in the following.

3. Reserves/Resources of ores and fluorite/barite

The ROHSA study includes 139 occurrences covering 33 metalliferous resources and 6 industrial mineral resources. Because of a lack of certain data (for instance absolute concentration data for platin group elements) only 28 elements and 3 industrial minerals are included in reserve/resource statements (tab. 1).

	reserves			resources						
commodity	C	C_1	C_2	D	D_1	D_2	pM	other resource	world mine production 2007	share of reserves of world mine production 2007 in %
Aluminium		5.677.550	17.270.000						38.171.399	60,1
Antimony								14.000	175.951	0,0
Arsenic			55.070	3.500					45.181	121,9
Barite	1.069.950	700		4.941.500	2.105.000	350.000	1.670.000	546.600	7.851.438	13,6
Barite/Fluorite						900.000	760.000		no data	no data
Bismuth	3.255		11.040	400		1.500			6.707	213,1
Boron	6.473							41.348	3.270.638	0,2
Cadmium	1.004		47			1.400			18.806	5,6
Caesium				2.190					no data	no data
Copper	18.631		142.900	5.000		54.400		15.750	15.480.324	1,0
Fluorite	736.317	239.000	1.845.300	1.377.100	1.416.750	919.295	1.966.250	1.980	5.776.974	48,8
Gallium			6,88					0,38	40	17,2
Germanium			2,33		240			0,09	32	7,3
Gold								0,83	2.328	0,0
Indium	106		133,8					47,5	549	43,7
Iron	578.172			2.000.000				1.053.000	1.037.592.865	0,1
Lead		2.830	314.340	43.093		26.600	5.200		3.563.061	8,9
Lithium			33.000	84.900					41.518	79,5
Molybdenum			3.017		1.300				192.713	1,6
Nickel			12.435	8.987					1.581.096	0,8
Niobium					3250	3640			60.400	0,0
Rare Earths					19630	21980			124.622	0,0
Rubidium			46.000	107.600					no data	no data
Scandium		34	249	6	32	5		14	0,26	108603,8
Silver	85		269	138		1.390		855	20.163	1,8
Sulphur								605.000	59.705.728	0,0
Tantalum								1.000	985	0,0
Tin	204.713	7.700	274.378	45.493	96.268	4.660	116.000	24.380	300.360	162,1
Tungsten	34.446	2.900	16.503	8.910	90.604	68.400		6.959	55.687	96,7
Uranium		2.934	999	16.220	1.492	9.735		1.907	49.109	8,0
Zinc	225.466	1.595	258.027	71.106		95.000		85.000	10.764.631	4,5

Table 1:
Reserves/Resources of ores and fluorite/barite (including sulphur) in metric tons; see chapter 2 for definitions; data source (GKZ, 2008) and own calculations; world mine production after WEBER et al. (2009) with exception of indium (http://www.asianmetal.com/report/en/2007In_en.pdf), niobium (http://minerals.usgs.gov/minerals/pubs/commodity/niobium/mcs-2009-niobi.pdf) and tantalum (http://www.australianminesatlas.gov.au/aimr/commodity/tantalum.jsp#production); resources of rare earths (RE) as RE_2O_3; world mine production of RE after WEBER et al. (2009) is calculated for „rare earths concentrates“

The examination of the reports showed, that calculations of reserves/resources of certain occurrences were too optimistic. Therefore, a critical analysis of each case is necessary, taking into consideration all currently available data.
Below cumulative reserve/resource data will be presented for typical groups of commodities. The geographic locations to the occurrences mentioned are available for download (see internet adress above). Detailed information regarding ore genesis, geological setting etc. are available in HÖSEL & LEHMANN (2009) and KUSCHKA (2009).

With regards to tonnages of reserves/resources available in Saxony, alumina, iron and sulfur occupy top positions (fig. 1).

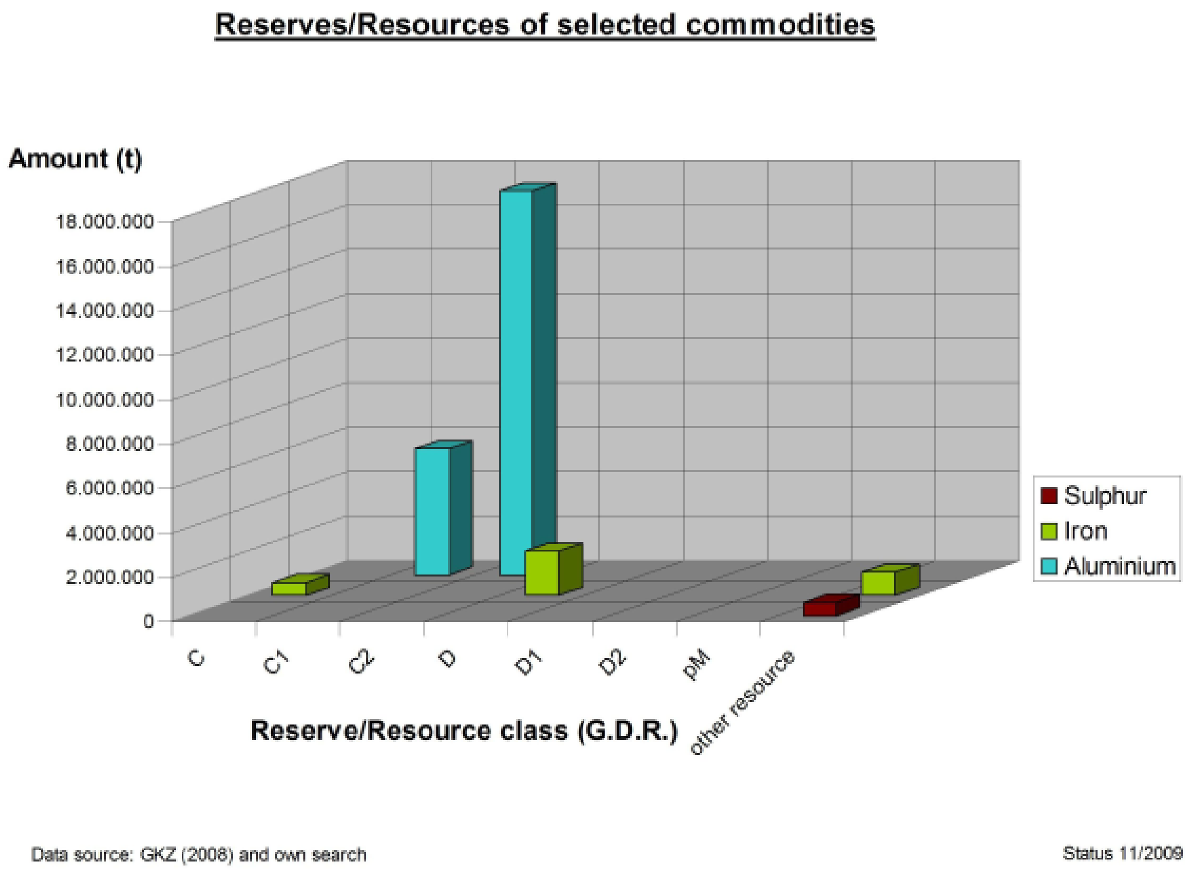

Figure 1: Reserves/resources of alumina, iron and sulphur in Saxony.

The resources/reserves of alumina were calculated in 1985 and relate to the occurrences Guttau and Kleinsaubernitz in the region of Lusatia. Here Al-rich clays (containing up to 30% Al_2O_3) occur (MINISTERIUM FÜR GEOLOGIE, 1985). Reserves/Resources of iron (magnetite) are predominantly contained in skarn occurrences (Delitzsch, Pöhla-Tellerhäuser). The amount of sulfur was estimated for the stratabound „Felsit" mineralisation in the area of Großschirma. Iron and sulphur would, however, only be by-products of the extraction of other metals (i.e. Sn, W or Zn). Production of Al from aluminous clays in Lusatia is for the foreseeable future certainly unrealistic.

All other commodities comprise maximal some 300.000 t per reserve/resource categorie (fig. 2).

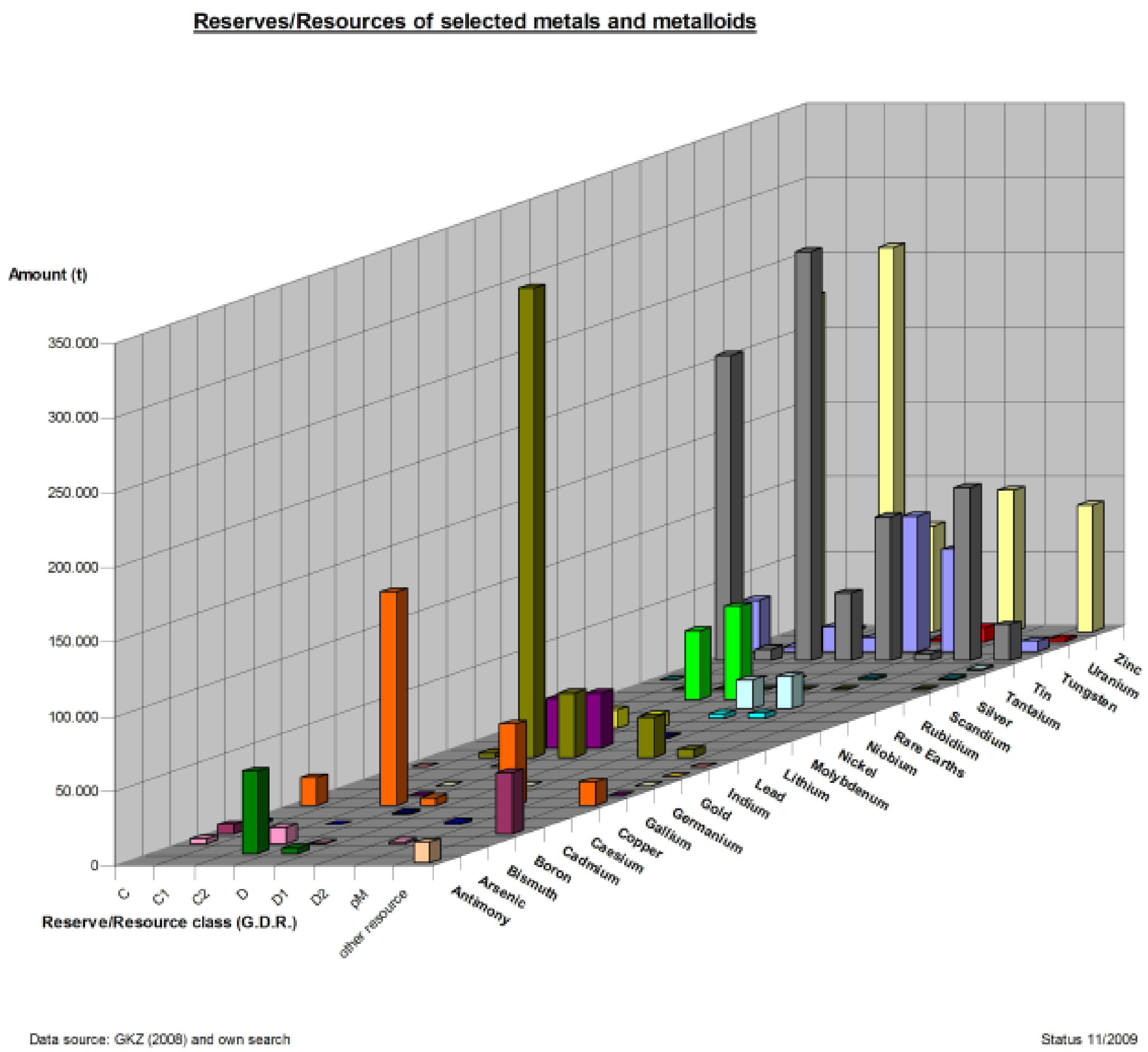

Figure 2: Reserves/Resources of selected metals and metalloids

Reserves/Resources of the base metals (Pb, Cu, Zn and Sn) are in the order of some hundred kilotons (kt) (fig. 3).

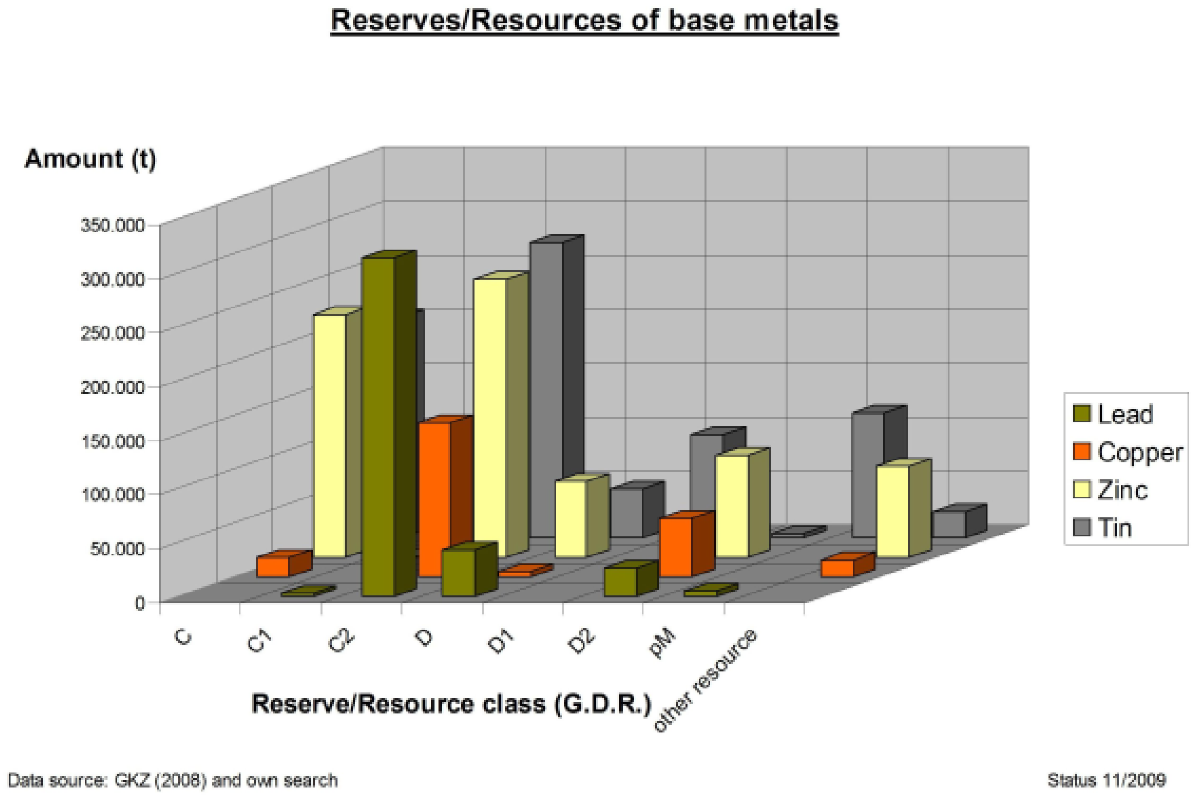

Figure 3: Reserves/Resources of selected base metals

The dominant portion of the reported reserves of lead are contained in the Kupferschiefer (copper shale) of the Schleife deposit (approx. 160 kt Pb c_2) (HENNIG ET AL., 1974). Exploitation appears likely only as a by-product of copper (approx. 78 kt of Cu c_2) and zinc (approx. 62 kt of Zn c_2) mining. Pb-rich polymetallic vein-type occurrences are located in the district Halsbrücke – Freiberg – Brand-Erbisdorf (approx. 140 kt C_2 reserves of Pb) (ROHRLACK ET AL., 1969).

The available reserves/resources of copper include not only the Kupferschiefer, but also the greisen occurrence Gottesberg (approx. 60 kt C_2 of Cu) (SIPPEL ET AL., 1983). The 45 kt of Cu reported for the stratiform occurrence Klingenthal is speculative and requires further detailed investigation (SIPPEL ET AL., 1985).

Major reserves/resources of zinc are contained in stratabound polymetallic sulphide deposits. Of particular importance is the area Pöhla – Hämmerlein – Tellerhäuser – Antonsthal - Breitenbrunn with overall C_2 reserves of 250 kt of Zn as well as further 95 kt prognostic resources (FRITSCH, 2002; WISMUT GMBH, 1999). Vein-type occurrences in the Freiberg – Brand-Erbisdorf district contain significant reserves/resources, of which approx. 150 kt of Zn are verified and 37 kt of Zn prognostic (ROHRLACK ET AL., 1969).

Deposits and occurrences of tin in the eastern Erzgebirge and and Vogtland were extensively explored and exploited in the Ehrenfriedersdorf und Altenberg mines until 1991. Especially voluminous remaining reserves/resources are contained in the occurrences Gottesberg (greisen-type orebody, approx. 100 kt C_2 of Sn, SIPPEL ET AL., 1983), the area Pöhla – Hämmerlein – Tellerhäuser - Antonsthal - Breitenbrunn (skarn-type deposits, ca. 205 kt C_2 and 83 kt of prognostic resource of Sn; FRITSCH, 2002; WISMUT GMBH, 1999), the area Altenberg – Sadisdorf (greisen-type deposit, approx. 120 kt C_2 and approx. 20 kt prognostic Sn content; WEINHOLD, 2002; BERGER, 1980; FELIX ET AL., 1990; HÖSEL, 1990; HÖSEL ET AL., 1990) as well as possibly the stratabound „Felsit“ mineralisation in the district Großschirma-Halsbrücke (sulphide mineralisation, approx. 70 kt pM; HOTH ET AL., 1985). Although the contained reserves/resources are very considerable, exploitation is inhibited by low grades

(mostly ≤ 0,5 % Sn), fine grain size (mostly << 1 mm) as well as the intimate intergrowths with deleterious minerals (for instance calcite).
The alkali metals lithium, rubidium and caesium occur in concentrations of economic interest in dark mica (zinnwaldite-group) of greisen-type deposits. Reserve/resource estimates exist for some occurrences in the eastern Erzgebirge (fig. 4).

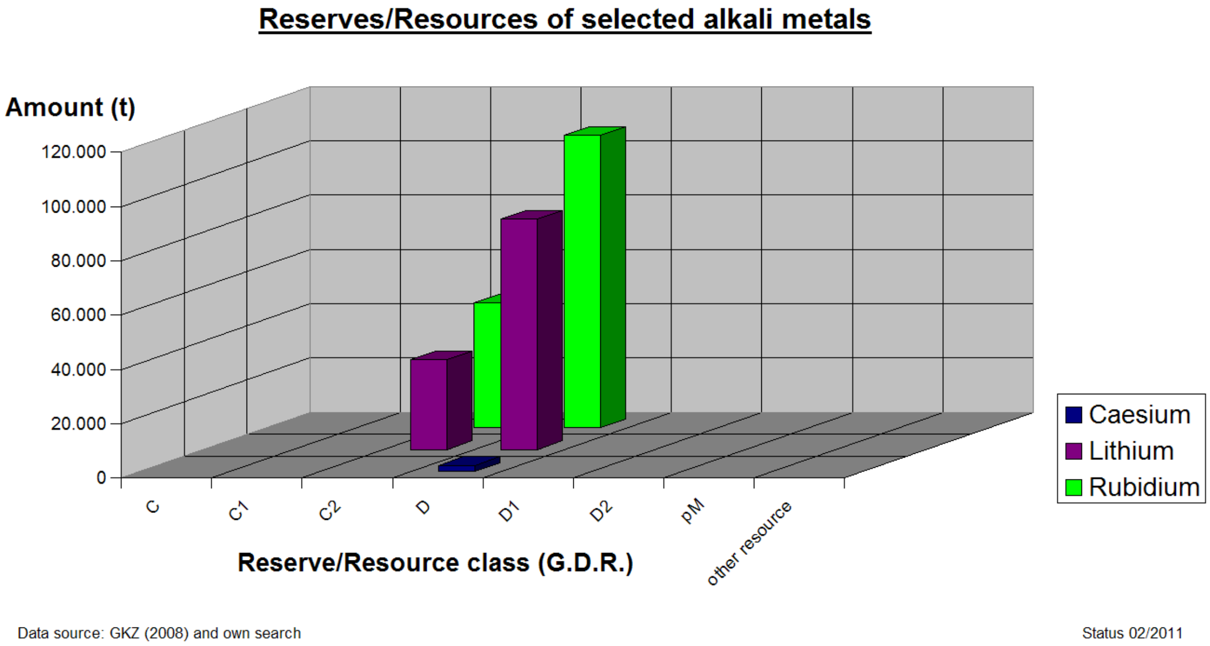

Figure 4: Reserves/Resources of selected alkali metals

Especially remarkable are Altenberg (33 kt Li and 46 kt Rb of C_2; < 1 kt Cs of other resource; WEINHOLD, 2002; RÖLLIG, 1990), Zinnwald (48 kt Li, 45 kt Rb and 1 kt Cs of prognostic resources; GRUNEWALD, 1978) as well as Schenkenshöhe northern of Altenberg (35 kt Li and 56 kt Rb of prognostic resources; < 1 kt Cs of other resource; RÖLLIG, 1990).

Among the ferro-alloy metals tungsten has the greatest importance in Saxony (fig. 5).

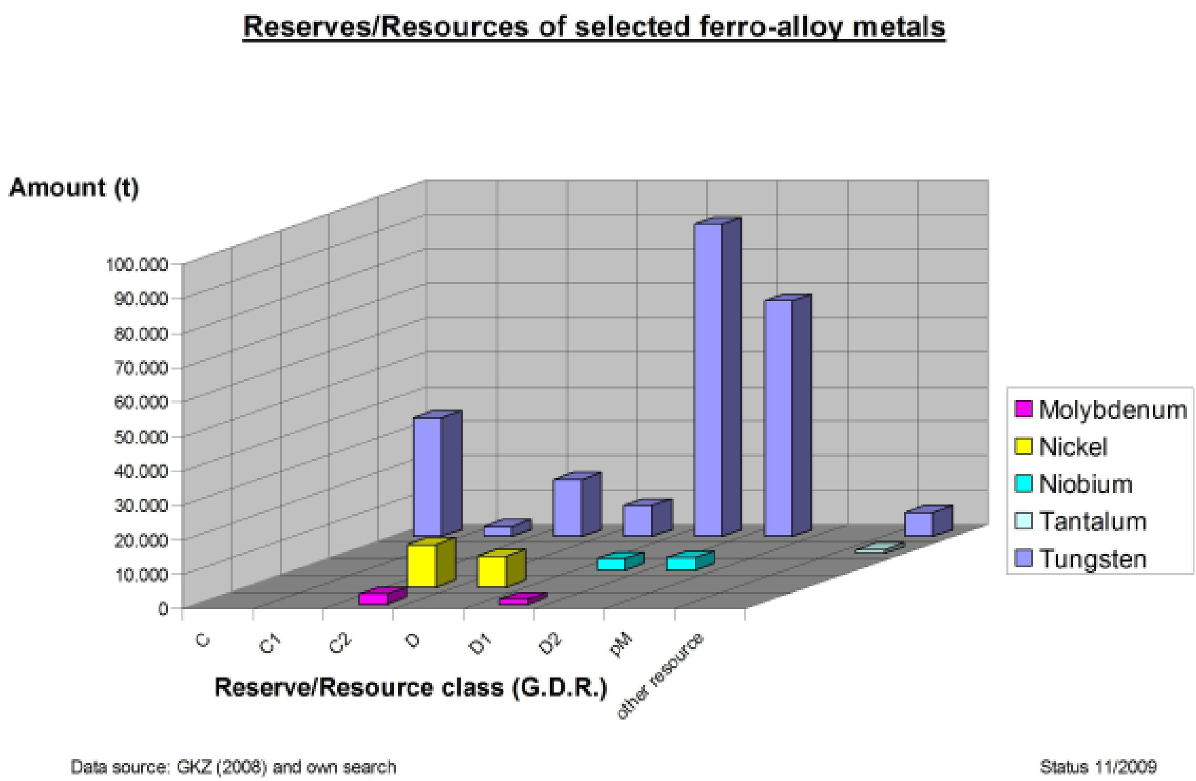

Figure 5: Reserves/Resources of selected ferro-alloy metals

For the area Bernsbach to the east of Aue a large amount of prognostic tungsten resource was estimated in the 1980's. However, this needs to be verified, similar to the 23 kt of prognostic (D_1) resource of the occurrence Antonsthal (FRITSCH, 2002). Both are scheelite-bearing skarn occurrences, similar to the occurrences in the area Pöhla-Globenstein (ca. 34 kt; WISMUT GMBH, 1999) and Delitzsch. For the latter occurrence resource figures had to be adjusted downward as a result of a detailed exploration campaign to approx. 17 kt (D) at subeconomic grades (ca. 0,2 % W) (KAMPE ET AL., 1990). Prospects for economic exploitation of W in Saxony are more likely as a by-product of tin exploitation, with wolframite as the main W-mineral. Estimates for the Gottesberg occurrence yielded 5,5 kt C_2 of W (SIPPEL ET AL., 1983), similar are reserves/resources for Sadisdorf (4 kt; FELIX ET AL., 1990) and Altenberg (9 kt; WEINHOLD, 2002). Worthy of a more detailed assessment appears the possible exploitation of W-occurrences in the areas around Aue-Bärengrund and Weißbach by small-scale mining operations, as previously performed at the now exhausted Zschorlau deposit. At these small deposits recovery of wolframite as the dominant W-ore mineral would be much easier than concentration of scheelite from skarn occurrences. As in previous examples, verification of mineral resources/reserves is considered essential.
Data for the abundance of tantalum are available only for two occurrences of tin in the eastern Erzgebirge. In the Schenkenshöhe occurrence Ta is associated with mica, with approx. 0,01 % fo Ta in the ore, and a total amount of approx. 1 kt of Ta (other resource) (RÖLLIG ET AL., 1990). Cassiterites of the Altenberg deposit, on the other hand, contain ca. 0,05 % Ta (BOLDUAN, 1971).
The carbonatite complex Delitzsch is the only occurrence for which niobium resources/reserves have been reported (approx. 7 kt D_1 + D_2 of Nb). Analyses of cassiterites from Altenberg with 0,15 % Nb are from the year 1971 (BOLDUAN, 1971).
Reserve/resource estimates of a several kt of nickel exist for occurrences of nickel hydro-silicates associated with serpentinite in the the saxonian granulite massif ("Granulitgebirge"). Most important in the past has been the district Callenberg-Kuhschnappel. The amount of remaining and untouched reserves/resources depends largely on the future technology of processing of the low-grade ores that contain 0,X % Ni.

Subordinate amounts of molybdenum in the form of molybdenite frequently accompanies occurrences of tin/tungsten in Saxony. Some 3 kt reserves of the C categories of Mo have been verified in the tin ores of the Altenberg deposit. The tungsten occurrence Delitzsch contains also a resource of approx. 1,3 kt Mo (D-category) as molybdoscheelite.

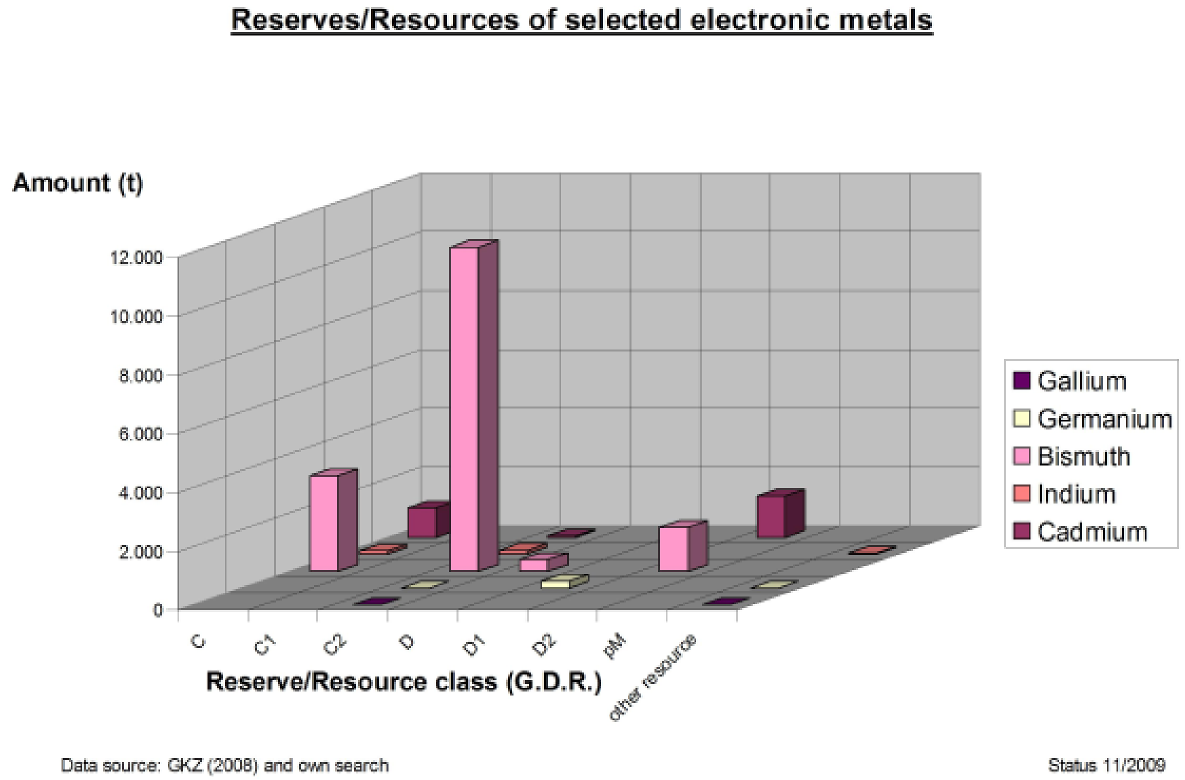

Figure 6: Reserves/Resources of selected electronic metals

Sphalerite in the vein-type deposits of the Halsbrücke – Freiberg – Brand-Erbisdorf district contain between 4 and 360 ppm Ga (ROHRLACK ET AL., 1969). Applying the latter value to the approx. 15 kt of remaining reserves of sphalerite (C_2) in the district Halsbrücke would yield some 5,6 t of contained Ga. The same sphalerite would also yield approx. 2,2 t of Ge (average content of Ge in sphalerite of Halsbrücke is approx. 150 ppm). Germanium is also present in concentrations of ca. 30 ppm in the tungsten ores of the Delitzsch occurrence, corresponding to a prognostic resource of approximately 200 t of Ge (calculation based on data of KAMPE ET AL., 1990 and SCHENKE, 1995).
Currently known reserves/resources of bismuth (occurring mostly as native bismuth metal) are predominantly related to tin occurrences of the Erzgebirge. The Gottesberg occurrence, for example, contains an estimated 7 kt C_2 reserves of Bi (SIPPEL ET AL., 1983); Altenberg, on the other hand, contains still ca. 4 kt of Bi (WEINHOLD, 2002).
Polymetallic base metal ores of the Erzgebirge are unusually enriched in indium, rendering this region as one of most indium-enriched ore provinces globally (SEIFERT & SANDMANN, 2005). Substituted especially into sphalerite, In may gain economic importance in the district of Freiberg and in the skarn occurrences of the western Erzgebirge. Estimates exist for Pöhla-Globenstein, where approx. 100 t of In have been reported as measured resources ("Außerbilanz" c_1+c_2) (HÖSEL ET AL., 2002). Containing an average of 0,1 % In (ROHRLACK ET AL. 1969; SEIFERT & SANDMANN, 2005) the remaining 128 kt reserves of sphalerite (C_2) of Freiberg would yield some 130 t of In. Smaller amounts (approx. 50 t C_2 of In) are estimated for Brand-Erbisdorf (approx. 97 kt sphalerite with an average of 0,05 % In).
Small amounts of cadmium (each with a few tenth to a couple of hundred tons) are contained in sphalerite of skarn occurrences in the western Erzgebirge (area Pöhla – Tellerhäuser) (WISMUT GMBH, 1999).

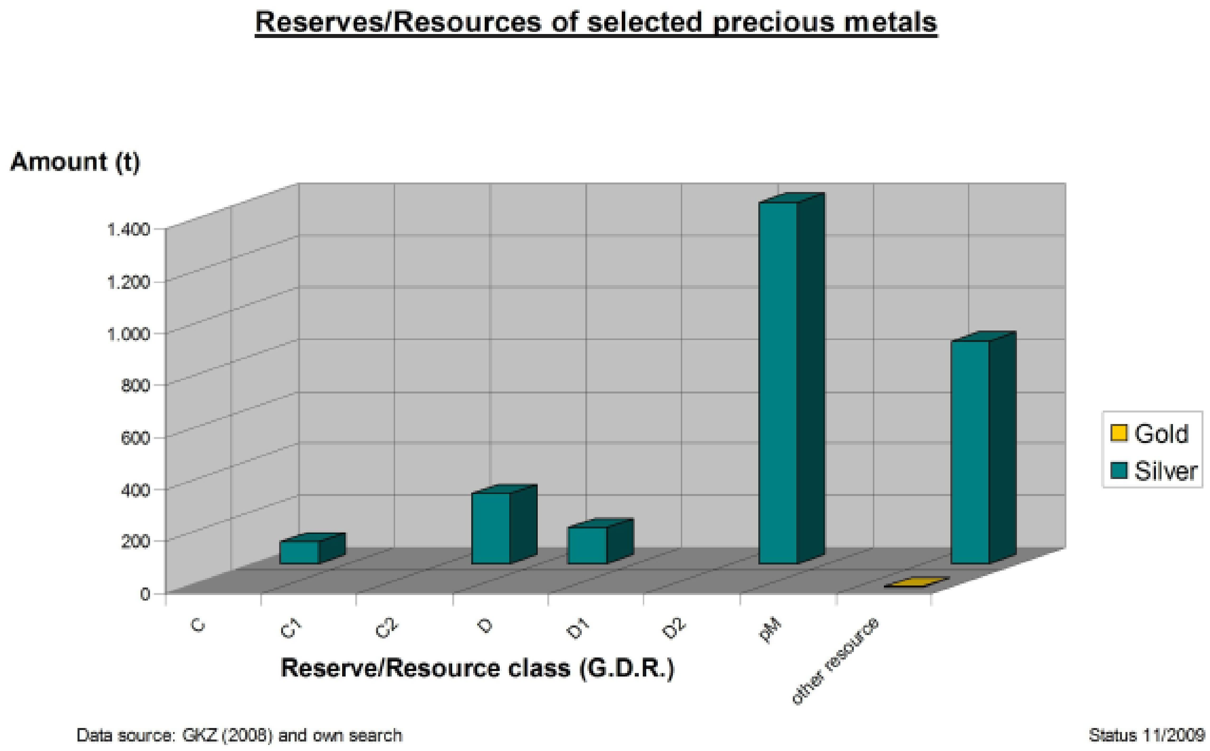

Figure 7: Reserves/Resources of selected precious metals

Among the precious metals the high silver concentrations of the vein-type deposits of the Erzgebirge have been of global importance. A total of some 8 kt of Ag metal have been extracted from these deposits (KRUSE, 1980). Estimates of remaining reserves/resources are in the range of some hundreds of tons (fig. 7) and are available, amongst others, for some vein- and skarn-type occurrences. A verification of the reported reserves/resources is required in every case. Most promising seems the polymetallic veins of the occurrence Brand-Erbisdorf as well as the Kupferschiefer occurrence in the area Weißwasser – Schleife.
Even less reliable are data concerning the occurrence and distribution of gold in Saxony. Although it is well known that gold is widely distributed in geologically recent fluvial sediments virtually nothing is known about its primary occurrence (LEHMANN, 2010a). The only resource estimate currently available is for the Gottesberg tin greisen occurrence. Based on the reported content of gold in sulphide concentratres an extractable amount of gold in the range of some 800 kg was appraised (LANGE, 1983). Rather realistic appears gold production as a by-product oft gravel and sand extraction especially in the Elbe-river gravels.

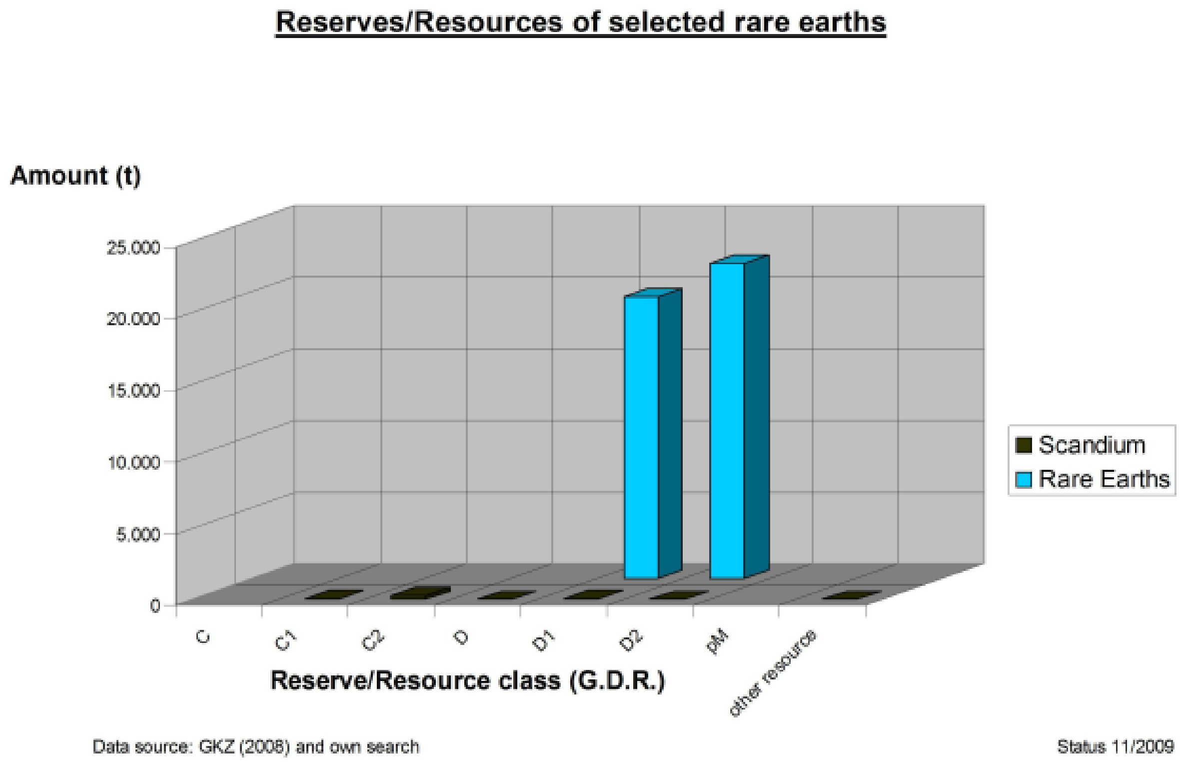

Figure 8: Reserves/Resources of selected rare earth elements (as RE_2O_3) and Sc

The only occurrence of reare earth elements (RE) in Saxony included in the ROHSA study is the carbonatite intrusion at Delitzsch/Storkwitz, near Leipzig. Finely disseminated bastnaesite as RE- and pyrochlor as a Nb-carrier occur in dolomitic matrix in this intrusion. Ta-contents in the pyrochlor are low, in the order of ca. 0,X %. Ce (48%), followed by La (27%), Nd (14 %) and Pr (5%) are the most common RE; the remaining elements occur in concentrations of ≤ 1,X %. As prognostic resource (D_1) some 20 kt RE_2O_3 were estimated down to -600m NN (RÖLLIG ET AL., 1984). A similar amount of D_2 resource may be contained in the intrusion between -600 and -900m NN (fig. 8).
Recent investigations of Scandium contents revealed remarkable concentrations in the eastern Erzgebirge region. Basing upon an average of 0,2 % Sc in cassiterite and 0,3 % in wolframite resp. (KEMPE & WOLF, 2006), some 150 t (C_1 + C_2) plus 30 t (prognostic and other resources) Sc is contained in tin-tungsten ores of Sadisdorf, Altenberg and Zinnwald. Questions of processability are not discussed yet.

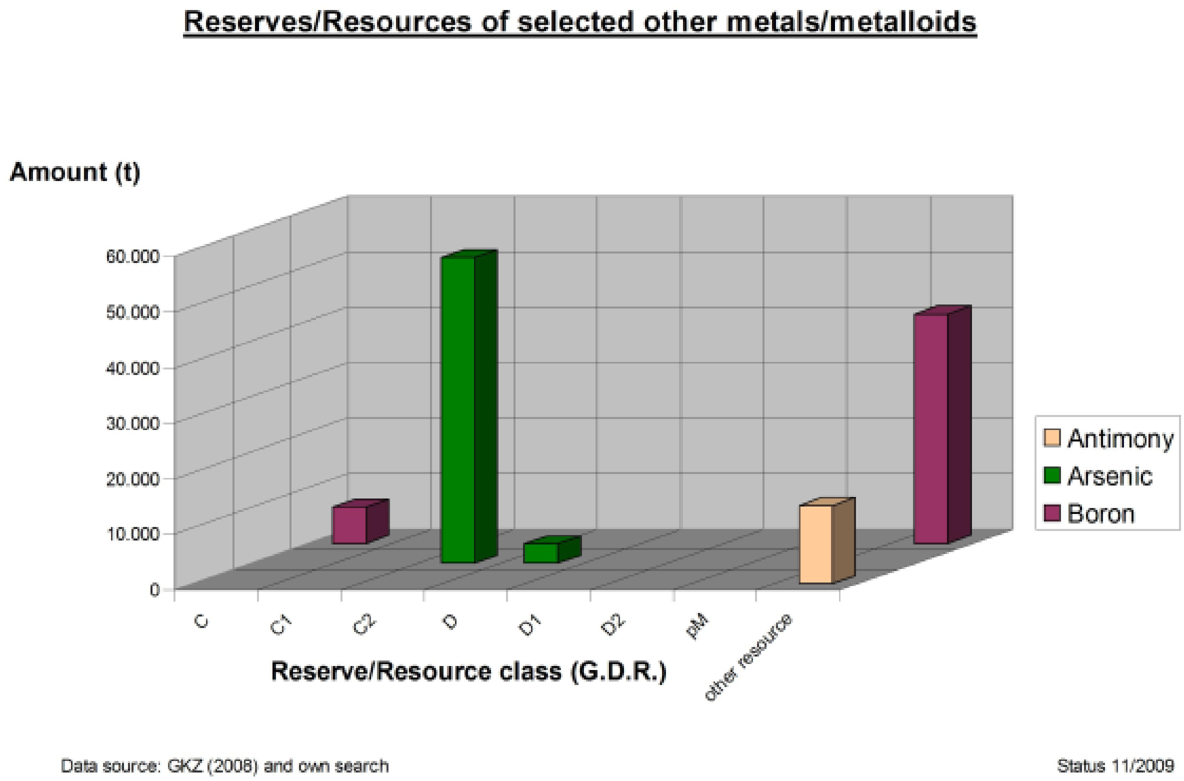

Figure 9: Reserves/Resources of selected other metals/metalloids

Ores containing significant concentrations of antimony have been exploited in the past in Saxony, in particular at Bräunsdorf near Freiberg. Resource estimates, however, exist only for the occurrence Dorfchemnitz – Hormersdorf. Exploration drilling documented veinlet-hosted mineralisation with bertierite and antimonite to depths of 1.400 m containing an estimated 14 kt antimony (FRITSCH, 2002) (fig. 9). This estimate would, however, have to be verified by detailed exploration. Of note are selenium contents between 500 and 900 ppm in the wall rocks to this occurrence (BOLDUAN, 1971).

Arsenic – mostly contained in arsenopyrite - is a typical minor commodity that accompanies tin in occurrences of the Erzgebirge. Resource estimates are available, for example, for Altenberg (30 kt of As reserves of C_2; WEINHOLD, 2002) as well as Ehrenfriedersdorf Northwest (approx. 16 kt of As of C_2; HÖSEL ET AL., 1985; actualized with HÖSEL, 1994).

Tourmaline ist the most frequent carrier of boron in Saxonian ore deposits. This mineral is widely spread especially in the contact aureoles around granitic intrusions of the western Erzgebirge. Resource estimates are, among others, available for the locality Sauschwemme at Johanngeorgenstadt (approx. 11 kt, other resource). At this locality a combined extraction with tungsten (approx. 1,5 kt) and tin (ca. 4 kt) from different soft rocks was considered (LESCH, 1979).

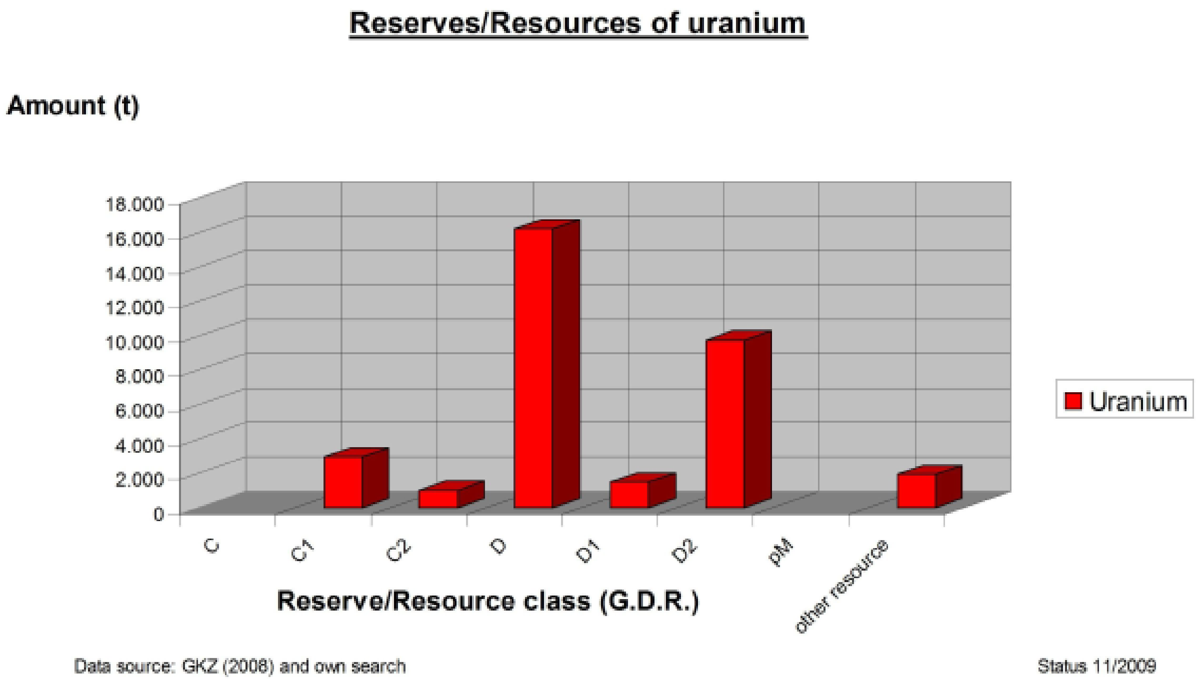

Figure 10: Reserves/Resources of uranium

Between 1946 and 1990 the former G.D.R. ranked among the world's largest uranium producers with a share of perhaps 13 % of total global production. Deposits in Saxony contributed some 125 kt of U to this production. The former Königstein mine, which is currently being flooded, contains remaining reserves (B + C) of 3,2 kt of U as well as some 4,2 kt of U of prognostic resources. The occurrence Tellerhäuser contains some 750 t uranium reserve (C_1+C_2), as well as some 4,5 kt of U of prognostic resources (D_1 + D_2) and the northwestern flank with a further estimated 6 kt of U resource (WISMUT GMBH, 1999). The knowledge of prognostic resources contained in occurrences of northwestern Saxony (Kyhna-Schenkenberg and Serbitz, each with some kt of U) is low. The same applies for resources of the area of Neumark-Hauptmannsgrün (ca. 2,3 kt of U) as well as Bernsbach (approx. 4 kt of U) (fig. 10).

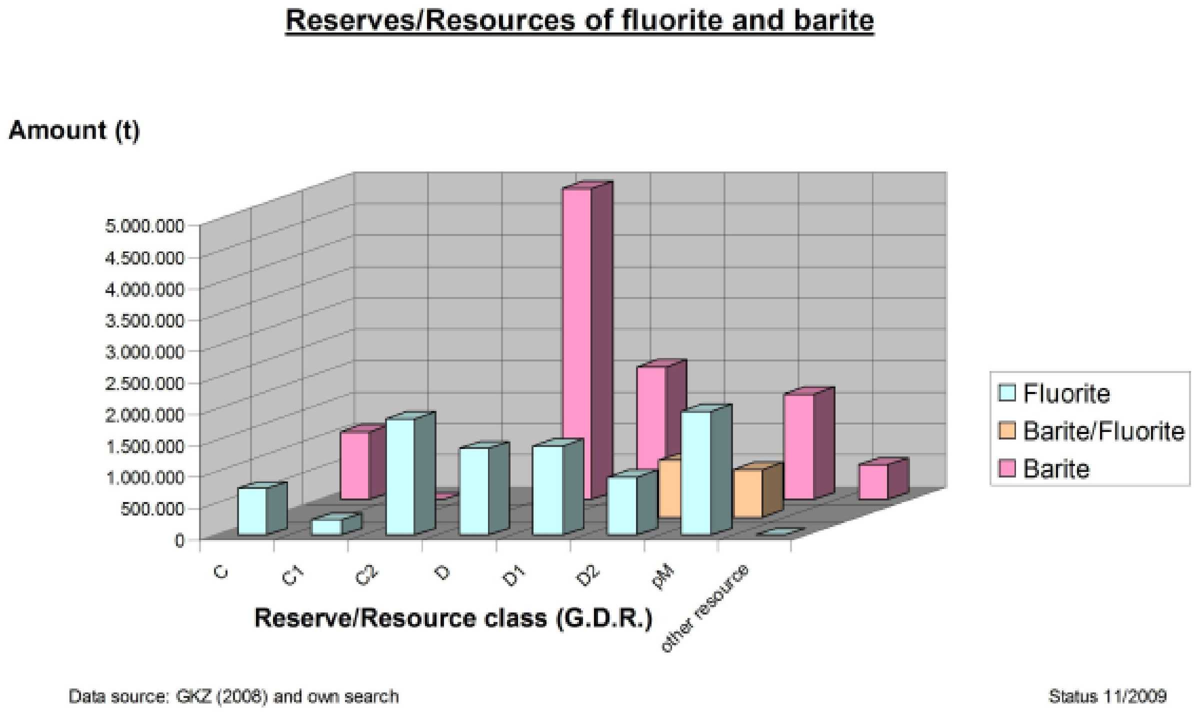

Figure 11: Reserves/Resources of fluorite and barite

Fluorite and barite were produced until the end of existence of the G.D.R. in the mines Schönbrunn/Bösenbrunn and Brunndöbra. Because of the particular economic relevance of these raw materials extensive exploration efforts were undertaken in Saxony, but cut short as a result of the German reunification. There are considerable reserves/resources remaining in the formerly operating mines of Schönbrunn/Bösenbrunn and Brunndöbra (fluorite in Schönbrunn: 221 kt C_1 + 668 kt C_2 + 103 kt D_1; fluorite Bösenbrunn: 18 kt C_1 + 407 kt C_2 + 310 kt D_1 - KUSCHKA & HAHN, 1996; barite Brunndöbra: 451 kt C + 1.745 kt D - ILGNER & HAHN, 1998). In addition, there are voluminous untouched reserves/resources known in the middle and eastern Erzgebirge. This includes, for example, Niederschlag (some 1.400 kt C + D_1 fluorite – KUSCHKA, 2002), Augustusburg-Zschopau, Langenstriegis, Halsbrücke, Brand-Erbisdorf, Lichtenberg-Weißenborn, Teichhaus, Schlottwitz as well as some further localities, each with a few hundred up to more than a thousand kt barite and/or fluorite. Although they may be of significant economic importance according to the available exploration results, these occurrences have not been investigated further since 1990 (KUSCHKA, 2009) (fig. 11).

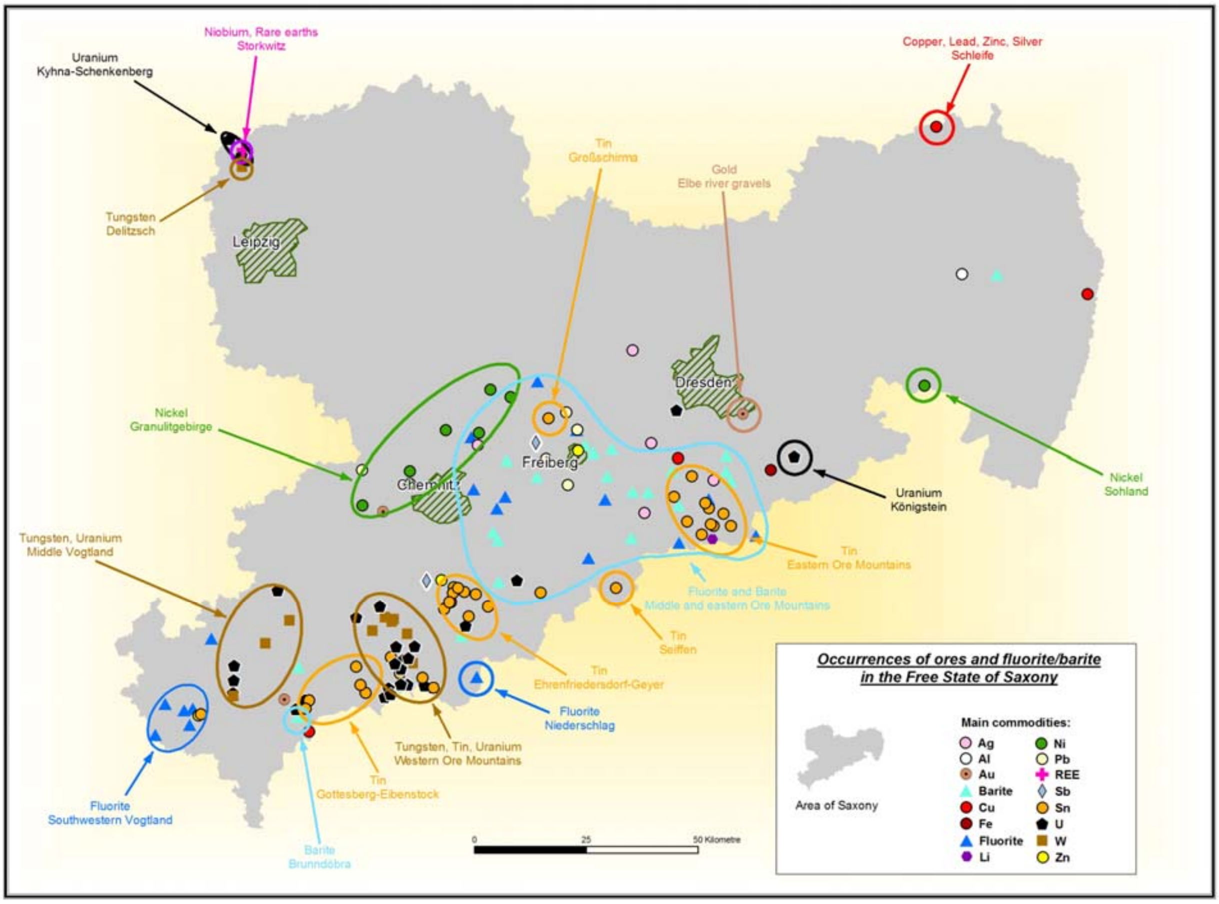

Figure 12: Geographic overview of the most important ore and fluorite/barite occurrences according to GKZ (2008) and own investigations

Figure 12 shows the geographic distribution of the most important ore and fluorite/barite occurrences.

4. Perspective

During the recent mineral resource boom 14 new exploration licenses were granted in Saxony (since 2006). An evaluation of the submitted applications by the State Geological Survey revealed in some cases substantial deficits. Deficits encountered ranged from the confusion of relevant ore minerals (for instance wolframite and scheelite) and inadequate exploration programs for too large areas to serious errors in planning (e.g., field limits defined directly over most prospective ground; exploration of a commodity in areas verified free of it). Another important problem has been an underestimate of the complexities of the required mineral processing. As yet, the expectation of an imminent resurgence of metalliferous ore mining in Saxony has not been fulfilled – a fact that is also due to the rapid decrease of world market prices for raw materials since the onset of the global financial crisis in 2008.
A reduction of the global need for primary mineral resources is, at present, not to be expected. Only the future will show, if demand and exhaustion of (high-grade) deposits can be met by increasing efficiency at the use of primary and secondary raw materials as well as the search and exploitation of deposits of increasingly lower grade. At least some specialized metals, such as rare earths or indium, are marked by rapidly increasing demand and rising prices. This could render mining of polymetallic base metal ores more profitable.
Small occurrences, for example of tungsten in the district Aue-Lauter, Wiesenburg or nickel in upper Lusatia, have as yet received little attention. From the viewpoint of mineral processing these occurrences are, however, preferable as compared to currently known larger

occurrences that are characterised by fine grain size, intimate intergrowths, the presence of deleterious minerals or silicates as ore minerals.
The abrupt termination of ore and fluorite/barite mining associated with German reunification in 1990 resulted in stagnation of our knowledge concerning ore deposits in Saxony – beside a few exceptions (for example the Kupferschiefer and Cu-Ni-mineralisation of Lusatia; reconnaissance studies regarding the distribution and abundance of gold in sediments and hard rocks). The short-lived mineral rush between 2006 and 2008 has - to a large extent - ebbed away. However, the rush highlighted the need for research, based on the currently still available personnal/intellectual expertise and material (archives, drill core collection). The ROHSA-Project created a starting point to further investigations. It has become clear that there is little reason to assume that Saxony is depleted of resources of ores and fluorite/barite. Despite rather intensive geological exploration of the state territory in the past, the available primary geological data represent only „pinpricks“ into the Earth's crust – they are insufficient to cover the mineral deposit potential of Saxony. The zone of the Earth's crust economically accessible with today´s mining methods extends beyond the existing mineral exploration data for most commodities. As an example may serve the deep-seated mafic intrusion in Lusatia that has often been regarded as a possible source of disseminated Cu-Ni-mineralisation at surface. The presence of such a deep-seated body has been invoked since the 1980's, based on close similarities in geological setting to world class orthomagmatic Cu-Ni deposits. Geophysical exploration and cost-intensive exploration drilling necessary to test the presence of this body has not been carried out yet. An initial start-up could, for example, be represented by a research drill core, at least 2.000 m deep that would also be useful in other context (geoscientific research, assessment of the potential utilisation of deep geothermal energy in the region).
Less expensive investigations could focus on the assessment of the economic potential of fluorite/barite occurrences in the middle and eastern Erzgebirge, the stratabound „Felsit“-type polymetallic mineralisation to the north of Freiberg or the scheelite of the eastern Erzgebirge. The exploitation of gold as a by-product of the extraction of sands and gravels requires a cost-saving processing technology, a problem solved since 2007 at Rheinzabern in the Rhine valley. In Saxony especially the sediments of the Elbe river seem to be suitable, because the gold occurs in relatively large flakes (median grain size between 100 and 200 µm) and sand/gravel are produced at a level that will guarantee the necessary throughput. Reconnaissance investigations by the LfULG in selected open pit mines yielded promising results. On the contrary (glaci-) fluvial sediments of other regions seem to be less suitable because of lower gold contents and finer grain size.

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