ON THE OCCURRENCE OF TELLURIUM IN NORWEGIAN GALENAS

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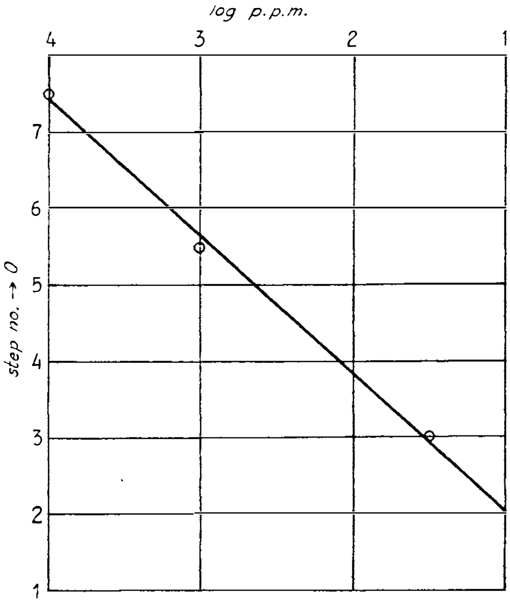
Abstract. Te has been observed spectrographically in but a few of the more common sulphide minerals. Of these galena is probably the most important. Not seldom Te concentrations considerably higher than 10 p.p.m. are found in galena specimens. The highest Te concentrations — more than 100 p.p.m. — are here nearly always accompanied by unusually high contents of Bi and Tl. On the whole the element association Te-Bi-Pb-Tl is very characteristic in sulphidic environment.

Tellurium is a rare element. The average content of Te in the lithosphere is not yet known with any degree of certainty. Based on data given by I. and W. NODDACK (1) (2) V. M. GOLDSCHMIDT (3) quoted the figure 0.0018 p.p.m., but actually he did not believe in this figure. On the contrary, for theoretical reasons he assumed the average Te concentration to be considerably higher. In the iron phases of meteorites he even thought that it might be as high as 10 p.p.m. Nevertheless the Te contents of most common minerals appear to be too low to be detected by direct spectrochemical analysis, i.e. well below 10 p.p.m.

It is well known that Te is highly enriched in certain types of sulphidic ore deposits, in particular in association with Au. The gold (and silver) tellurides are, however, rare minerals, and so are the known tellurides of Bi, Cu, Ni, Pt. Te is also enriched to some extent in pyrrhotite-pentlandite ores and in certain copper ores. From the latter the the production of Te metal is obtained. It is also known that rather high Te contents may be found in galena (3).



The present paper reports on the spectrographic examination of a considerable number of Norwegian galenas, and some other minerals. The spectrograms were taken with a Hilger "Large" quartz spectrograph by Mr. J. HYSINGJORD and Mr. F. WOLFF. The conditions of arcing etc. were essentially as described elsewhere (4). The exposure time was kept constant at 90 seconds, and a few not quite successful (weak) spectrograms were left out of consideration. The standard mixtures were made from sylvanite (Offenbanya) assumed to contain about 60% Te, and a Te-poor galena (Bjørnøya, see below) for base substance. In order to obtain fairly accurate estimates of the intensities of the Te line — 2385 — a rotating stepped sector was applied. Thereby the lines were divided into 7 intensity steps, the exposure time for the nth step being $90/2^{n-1}$ seconds. The intensity readings were made by recording the ordinal number of the vanishing step in each case. In this way the working curve shown in the figure was obtained from the standard mixture spectrograms. It is seen that the curve is a nearly straight line, so that one may assume that it will give fairly reliable results.

The results are summarized in the table. Within each of the groups I II III IV the specimens have been arranged according to increasing contents of Te. In a number of cases the contents of Tl, Bi and Sb have been added, these figures having been taken from an earlier paper (5). They are less accurate than the figures for Te, but they are sufficiently accurate to bring out the characteristic features. The determinations of Tl, Bi, Sb and Te have been carried out on the same specimen in all cases. The Ag contents, which have also been deter-

Tellurium contents of Norwegian galenas.

(The figures are logarithms of p.p.m.)

	Te	Tl	Bi	Sb
I. Contact deposits in the Oslo Region.				
Konnerud district (2 localities)	<1			
Grua district	<1			
—»—	<1	<1	<1	2
—»—	<1	<1	3	2
Konnerud district (2 localities)	1.0			
Korsegård, Eiker.....................	1.0	<1	2	2
Grua district	1.0			
—»—	1.3			
Konnerud district (2 localities)	1.7			
—»— (Wedelseie)	2.0	3	4	<1
Grua district (Nyseter)	2.0	<1	3	2
Kjenner Bi Mine (111-cleavage)	2.3			
—»— —»—	3.0	2	4	<1
Ia. Pegmatite, Langesundsfjord (Eikahl.)	2.0	<1	1	2
II. Mineral veins in Southern gneiss areas.				
Tråk, Bamble (2 samples)	<1			
—»—	<1	<1	3	3
Fiskum—Eiker district	<1			
—»—	<1	<1	3	3
—»— (2 localities)	<1	<1	1	3
Lassedalen, Meheia	<1	<1	2	2
Bergggård, Tyristrand	<1	<1	<1	2
Skuterud, Modum	<1	<1	<1	3
Jaren, Hadeland	<1			
Fiskum—Eiker district	1.0	<1	<1	2
—»—	1.0	<1	3	3
Espeland, Vegårdshei	1.3	2	2	4
—»—	1.7	2	4	3
Fiskum—Eiker district	1.7	<1	3	3
Sandåen, Gjerpen (111-cleavage)	2.3	2	4	<1
III. Western Norway.				
Krækkja, Hardangervidda	1.3	<1	3	3
Skjoldevik, Skjold (111-cleavage)........	2.3	2	4	2
IV. Northern Norway.				
Svenningdal Ag Mines	<1	1	3	4
Eiterjorden, Beiarn..................	<1	<1	2	3
Funta, Tysfjord	<1	<1	3	3
Mosbergvik, Balsfjord	<1	2	<1	2
Jakobselv	1.0	<1	<1	2
Bjørkåsen Mines (111-cleavage) (3 sp.) ...	1.7			
—»— —»— (2 sp.) ...	2.0			
—»— —»—	2.3	3	4	1
V. Bjørnøya (Russehavna)	<1	<1	<1	3

mined, I have not quoted as they do not show any obvious correlation to the Te contents.

The occurrence of Te in galena does not seem to be markedly dependent on the geological environment. Both in the contact deposits of the Oslo Region and in the various hydrothermal deposits there are Te-poor galenas as well as galenas containing Te in concentrations of up to 200 p.p.m. or more. However, on the whole the galenas of the Oslo Region appear to be on the average somewhat richer in Te than those of the other districts. Relatively few of the former are lower in Te than 10 p.p.m., while in hydrothermal veins etc. such low Te contents are highly predominant. It is seen that the highest Te concentrations, 100 p.p.m. and more, are nearly always found in particularly Bi-rich galenas with octahedral cleavage, and that these galenas invariably exhibit Te concentrations of this order of magnitude. Such galenas are of course relatively very rare. But they occur in contact metasomatic as well as in hydrothermal deposits. Some of the Te-rich galenas do not show octahedral cleavage, e.g. specimens from Konnerud and Espeland, but are still rich in Bi (1000 p.p.m. and more) if not sufficiently rich for the octahedral cleavage to appear (6). The table contains one instance of galena which is rich in Te and poor in (actually nearly free of) Bi, but that comes from nepheline syenite pegmatite, which is, as is well known, very peculiar as to element associations.

Also Tl shows a strong tendency to be enriched along with Te. But this is probably due to the association Tl-Bi which is a very striking feature in particularly Bi-rich galenas.

The table contains one instance of a rather Tl-rich galena which is extremely poor in Te and Bi (Mosbergvik), and one less pronounced case (Espeland 1). This shows that Tl may appear independenty in galena.

Between Te and Sb there is a distinct negative correlation. In particular the very Te- (and Bi-) richest galenas are extremely poor in Sb. In this case too the real negative correlation is probably between Sb and Bi.

Conclusion.

Even if galena appears to be on the average the Te-richest of the commoner minerals its Te content is in the majority of cases lower than 10 p.p.m. In the relatively very rare galenas exhibiting Te contents of 100 p.p.m. and upwards the association with high amounts of Bi and Tl is very characteristic. I am not able to explain this adequately. Crystal chemical principles of course will allow Te as well as Tl and Bi to replace S and Pb respectively in the galena structure, but they will not explain why these elements enter galena in company (except perhaps in the case of Tl and Bi which would to some extent compensate each other electrostatically). Exceptional cases (Langesundsfjord) also show that Te may enter galena independently. The characteristic association Pb-Tl-Bi-Te must be due to geochemical conditions regulating the supply of elements during the formation of these rather unusual Pb ore deposits. The quantities of these elements contained in a parent granite magma may have been largely concentrated in these deposits due to special chemical physical and geological conditions. Since the galenas of the Oslo contact deposits appear to be relatively rich in Te, and since the absolutely Te-richest galenas appear to belong to the very Bi- and Ag-rich type found in certain high temperature deposits (6), there is some reason to believe that the enrichment of Te in galena is promoted by high temperatures. Therefore Te-rich galenas are probably in general of high hydrothermal or pneumatolytic origin.

Other minerals — essentially sulphides — are being examined in this institute for their contents of Te. It may be added here that the association Te-Bi(-Pb) is strikingly apparent also in all examined bismuthinites and "galeno-bismuthinites" (6 Norwegian localities), which exhibit Te concentrations from about 100 p.p.m. to about 5000 p.p.m. (bismuthinite from Bastnäs in Sweden has been shown more than 50 years ago to contain 9500 p.p.m. Te (7)). Also the existence of minerals like tetradymite demonstrates this association. Otherwise there seems to be but few mineral species which may contain Te in concentrations higher than 10 p.p.m. Among these is bornite (Mosnap, Telemark, 30 p.p.m.).

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