# LEAD CONTENTS IN MICROCLINE FROM SOME GRANITES AND PEGMATITES

By

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**Abstract.** Average Pb-contents found in microcline samples: from the Östfold granite and Östfold pegmatites ~ 100 ppm, from the Grimstad and Herefoss granites ~90 ppm, from some Bamble-Kragerö pegmatites <10 ppm, from Iveland-Evje pegmatites ~300 ppm. One locality near Lillesand shows fairly constant Pb-contents in spite of highly varying Sr- and Ba-contents. The results are discussed.

## Introduction

The lead contents of some alkali feldspars from southern Norway were preliminarily published by me some years ago (Oftedal 1954). These spectrochemical investigations have been resumed at the Institute of Geology.

New standard mixtures were prepared essentially as were the old ones: the base substance was a pegmatite microcline which had been found to be extremely poor in Pb. This was mixed with glass powder containing 30% PbO to give mixtures containing 1000, 100, and 10 ppm Pb. Repeated exposures of these gave well-defined intensity curves for the Pb lines 2833 and 2802. Evidently, it is reasonable to assume that these curves will give reliable values when applied to spectrograms of common microclines. On the other hand, it should be pointed out that in the present case the nature of the base substance of the mixtures is highly important: corresponding standard mixtures made with albite instead of microcline gave much higher Pb line intensities. The limits of error of individual Pb determinations are estimated at about $\pm$ 10%, in some cases perhaps towards $\pm$ 20%.

All examined microcline samples came from the Precambrian areas on both sides of the Oslo Region, i.e. from part of Östfold and from the Sörland (taken in a somewhat wide sense) (Fig. 1). They were all taken

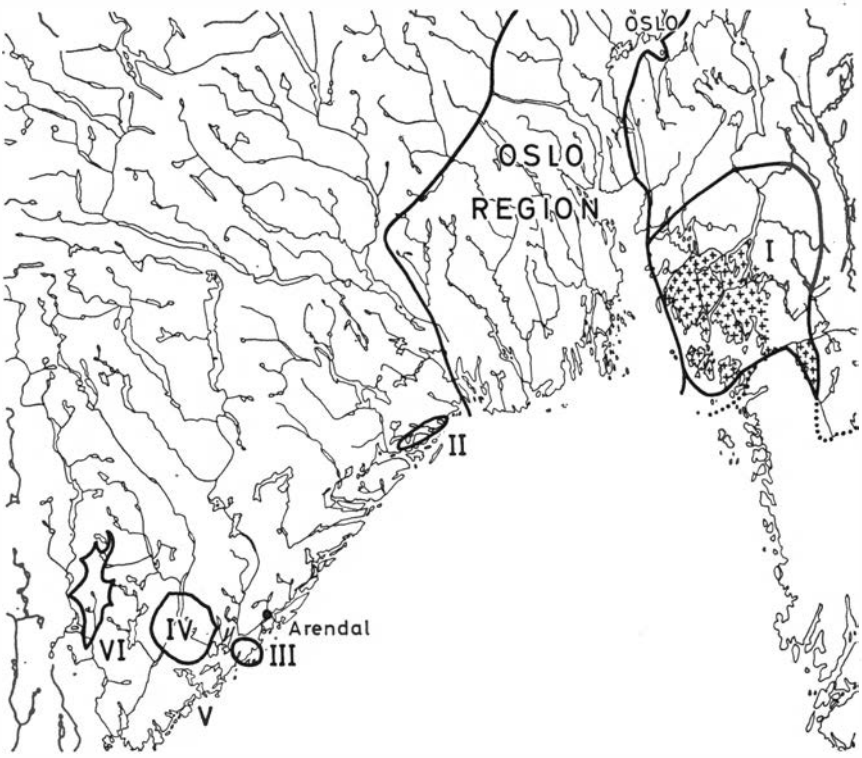


Fig. 1. Key map.

from more or less coarse-grained rocks, so that pure microcline could be easily hand-picked. Most of the results are summarized in the Table, and the main features of the Pb-distributions are shown in Fig. 2.

## Comments

### I. Östfold granite and its northern surroundings

Most of the *granite* specimens were collected between Råde railway station and the environs of Fredrikstad. The *pegmatite* localities are distributed all over the area outlined in Fig. 1. Some of them were mentioned by BRÖGGER (1906), and a large number—in particular those east of the River Glomma—were described by BROCH (1934). The pegmatites *within* the granite body are mostly small dikes and veins; originally, it was intended to collect these into a separate group

Table

*Pb-determinations in microcline samples. N = number of samples. Roman numerals refer to the areas shown on the map (Fig. 1)*

| | | Pb, ppm | N |
|---|---|---|---|
| I. Östfold(–Bohus) granite | | 150 | 3 |
| | | 120 | 1 |
| | | 100 | 7 |
| | | 60 | 1 |
| | Mean | 110 | 12 |
| Östfold pegmatites | | 350 | 1 |
| | | 200 | 1 |
| | | 150 | 7 |
| | | 120 | 12 |
| | | 100 | 34 |
| | | 80 | 12 |
| | | 60 | 3 |
| | | 50 | 6 |
| | | 40 | 1 |
| | | 30 | 1 |
| | Mean | 100 | 78 |
| II. Bamble–Kragerö pegmatites | | ≷ 10 | 12 |
| III. Grimstad granite | | 120 | 4 |
| | | 100 | 3 |
| | | 80 | 2 |
| | | 60 | 1 |
| | | 40 | 1 |
| | Mean | 95 | 11 |
| IV. Herefoss granite | | 120 | 3 |
| | | 100 | 3 |
| | | 80 | 4 |
| | | 60 | 1 |
| | | 50 | 4 |
| | | 40 | 2 |
| | Mean | 80 | 17 |

| | | Pb, ppm | N |
|---|---|---|---|
| V. Lillesand pegmatite | | 120 | 1 |
| | | 100 | 4 |
| | | 60 | 5 |
| | | 50 | 1 |
| | | 30 | 3 |
| | Mean | 70 | 14 |
| VI. Iveland–Evje pegmatites | | 500 | 1 |
| | | 400 | 1 |
| | | 300 | 2 |
| | | 250 | 1 |
| | | 200 | 3 |
| | | 150 | 1 |
| | Mean | 280 | 9 |

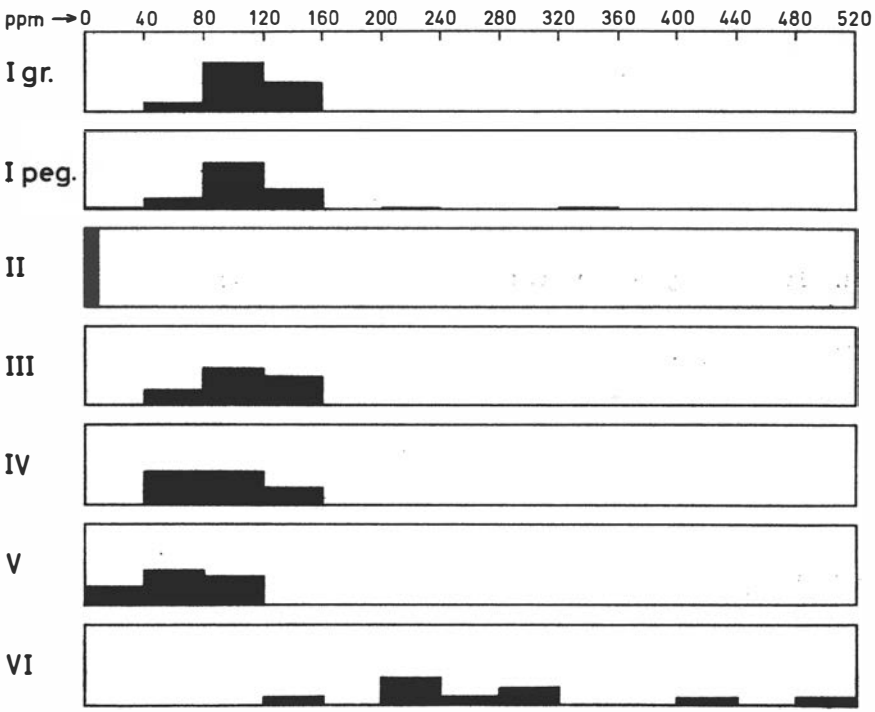


Fig. 2. Histograms. The roman numerals correspond to the Table. Ordinates are percentages of the total number of samples within each group.

in the Table, but it soon became apparent that their microclines did not differ notably from those of the external pegmatites as to average Pb-contents, and therefore all Östfold pegmatites were included in one group. It is seen that the magnitudes and distributions of the Pb-contents are very nearly the same in granite microclines and pegmatite microclines. Pb-contents higher than about 150 ppm are extremely rare; the two instances recorded occur very far outside the granite boundary in the northernmost part of the outlined area. These observations are in support of a common origin of the Östfold–Bohus granite and its surrounding granite pegmatites.

**III and IV. Grimstad and Herefoss granite bodies**

The specimens examined have been taken from scattered localities within the granite areas. The distributions of Pb-contents are rather similar to those of the Östfold granite, but the average contents are distinctly lower. The difference in average Pb-contents between the Grimstad and Herefoss granites may not be significant, since the number of examined samples is rather small. According to our results, the Herefoss granite, the Grimstad granite, and especially the Östfold granite are substantially richer in Pb than the average granite. Assuming that microcline makes up about half the substance of these rocks (surely an underestimate), the Herefoss and Grimstad granites contain on the average about 45 ppm Pb and the Östfold granite more than 50 ppm Pb.

**II. Pegmatites in the Bamble–Kragerö coastal area**

Within the outlined area in Fig. 1, all examined microcline samples are very poor in Pb, the maximum content being of the order of 10 ppm. Similar low values are found also outside the outlined area, but here also higher contents are observed in some cases, up to 100 ppm. Samples from a few scattered pegmatites between Kragerö and Arendal show Pb-contents from below 10 ppm to about 150 ppm, in one case 400 ppm. These pegmatites have been described by ANDERSEN (1931).

**V. Pegmatite band in gneiss south of Lillesand**

All the examined samples have been taken within a surface area of only some square metres. Some of them will be discussed below.

**VI. Pegmatites in the Iveland–Evje amphibolite area**

These have been described by BARTH (1931) and BJÖRLYKKE (1935). The examined samples are very few as compared with the large number of pegmatites within the area. This explains the irregular appearance of the histogram (Fig. 2). Nevertheless, it is evident that these microclines are on the average very rich in Pb.

## Remarks on the crystal chemistry of lead

Apart from fairly moderate local variations, the Pb-contents of the microclines of the three Precambrian granites and the Östfold pegmatites are approximately on the same level, around 100 ppm. In comparison, the microclines of many Bamble–Kragerö pegmatites are very Pb-poor, and those of Iveland–Evje pegmatites very Pb-rich. The former fact is particularly striking. It has been reported earlier (OFTEDAL 1954) that no Pb could be detected in alkali feldspar (essentially orthoclase) from three localities within the Oslo Region granite ('Drammen granite'). The spectrograms in question were taken by the very sensitive 'Glimmschicht' method and prove that the Pb-contents must be far below 10 ppm. This granite is a high temperature rock surrounded by extensive contact aureoles in which a number of considerable galena deposits occur. It was concluded that under the prevailing (magmatic) conditions, Pb was predominantly chalcophile and was not taken up by the crystallizing alkali feldspar to any notable extent. It appears that Pb will not be taken up by alkali feldspar crystallizing above a certain temperature limit; a further condition may be the presence of S, but this is probably fulfilled in most cases.

It may be tempting to explain the low Pb-contents of Bamble–Kragerö pegmatite microclines by assuming a relatively high temperature of formation (or metamorphism) for these pegmatites. This may be in accordance with the occurrence of pyroxene in some of them (ANDERSEN 1931). However, the matter may not be so simple. We have tried the effect of heating on a very Pb-rich microcline, an amazonite containing nearly 1,000 ppm Pb. This was finely powdered and heated in an open tube at 950°C for 50 hours. The result was negative; there was no noticeable reduction of the Pb-content. Naturally, such an effect is hardly to be expected in the laboratory.

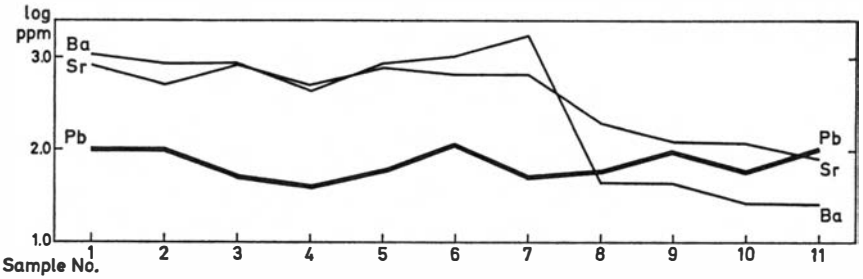


Fig. 3. Pb-contents compared with Sr- and Ba-contents in samples collected across one pegmatite band in gneiss. Width of band about 2 m. (See OFTEDAL 1959, Fig. 2, section V.)

It would represent a diffusion process, which is usually very slow except just below the melting temperature.

Considering only microclines from the above types of deposits, it appears that they have formed within a fairly narrow temperature interval, according to BARTH (1956) mostly between 550° and 600°C. The precise values are not important in the present discussion, but it is assumed that the temperature of formation does not vary greatly among the various deposits. This means that the observed Pb-contents do not depend on the temperature. The *saturating* Pb-content is probably temperature dependent, but this has clearly not been reached in any of the examined samples. The observed Pb-contents then appear to depend solely on the concentration of Pb which was present in the medium. The large pegmatites in Iveland–Evje and elsewhere, which contain very Pb-rich microcline, are usually enriched also in other rarer elements in relation to supposed mother granites. As to Pb, this may possibly indicate a high temperature of the mother granite 'magma'.

A number of the examined samples from the Lillesand pegmatite (V in the Table) have earlier been spectrochemically analyzed for Ba and Sr (OFTEDAL 1959). The results are shown in Fig. 3. The microclines clearly belong essentially to two generations, one rich in Ba and Sr and one extremely poor; the latter is the younger. It is supposed that a local supply of Ba and Sr was almost completely consumed by the early microclines. The Pb-contents, on the other hand, are essentially the same in both generations, i.e. they show neither 'capture' nor 'admission' towards microcline. Pb behaves more or less like K in this respect.

The behaviour of Pb towards alkali feldspar is quoted as an instance of disagreement with the 'capture-admission rule'. The above results do not contradict this statement, but they modify it in so far as there is a certain temperature level where the later crystals are *not* enriched in Pb.

**Acknowledgements**

I am indebted to state geologist J. Hysingjord for collecting specimens in the Östfold granite area, to cand. real. B. Nilssen for specimens from the Herefoss granite, to the Mineralogisk-Geologisk Museum and Norges Geologiske Undersökelse for numerous pegmatite specimens, to cand. real. Per Chr. Sæbö and Mrs. L. Heggelund for preparing the spectrograms, and to professor I. Th. Rosenqvist for making laboratory facilities at the Institutt for Geologi available.

REFERENCES

ANDERSEN, O. 1931. Feltspat II. *Norges geol. Undersök. 128 B.*

BARTH, T. F. W. 1931. Feltspat III. *Norges geol. Undersök. 128 B.*

BARTH, T. F. W. 1956. Studies in gneiss and granite. *Skr. Norske Vid.-Akad. Oslo. I. Mat.-Naturv. Kl. 1956. No. 1.*

BJÖRLYKKE, H. 1935. The mineral paragenesis and classification of the granite pegmatites of Iveland, Setesdal, southern Norway. *Norsk geol. Tidsskr. 14,* 211–311.

BROCH, O. A. 1934. Feltspat IV. *Norges geol. Undersök. 141.*

BRÖGGER, W. C. 1906. Die Mineralien der südnorwegischen Granit-pegmatitgänge, I. *Skr. Vid.-Selsk. i Christiania (Oslo) I. Mat.-Naturv. Kl. 1906. No. 6.*

OFTEDAL, I. 1954. Some observations on the regional distribution of lead in South Norwegian granitic rocks. *Norsk geol. Tidskr. 33,* 153–61.

OFTEDAL, I. 1959. Distribution of Ba and Sr in microcline in sections across a granite pegmatite band in gneiss. *Norsk geol. Tidskr. 39,* 343–49.

Accepted for publication January 1967