

# COMMENT ON THE Pb DISTRIBUTION IN SOUTHERN NORWEGIAN PRECAMBRIAN ALKALI FELDSPARS

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**Abstract.** Lead in 23 of the potassium feldspars previously analysed by emission spectrography (HEIER & TAYLOR 1959) was determined by X-ray spectrography. Pb determinations in some standard rocks are given for comparison. The wide range in Pb contents was confirmed. The extremely low Pb contents in pegmatite feldspars from Kragerö and Arendal are especially noteworthy.

## Introduction

Feldspars are the most important host minerals of lead in the crust; in spite of this and of the widespread interest in lead and lead isotopes, comparatively little data are available on lead contents of feldspars. This is striking when compared with the abundance of data on other trace elements like Rb, Sr, and Ba, and is related to the greater difficulties of Pb analysis. Because of this, early emission spectrographic lead determinations, summarized by HEIER (1962), are still widely quoted in the literature. Lead is a difficult element to determine by optical spectrography because of high volatility, low sensitivity, and some line interference problems as discussed by AHRENS & TAYLOR (1961).

A recent abstract by DOE & TILLING (1966) and discussions with Dr. Doe stimulated us to re-examine some of the Norwegian alkali feldspars described by HEIER & TAYLOR (1959) where sufficient material was still available.

### Procedure

A Phillips vacuum spectrograph with a 2 kW generator was used. The general method of sample preparation, determination of mass absorption coefficient, and analytical procedure was as described by NORRISH & CHAPPELL (1966) for heavy elements. The machine settings were: 60 KV, 32 mA, lower level 85, window 110, Mo target, fine collimator, LiF crystal, scintillation detector, analysis line Pb  $L\beta$  at  $28.2^\circ$ .

### Standards

There is a critical lack of suitable rock standards for lead. In this study, the recommended value of 49 ppm Pb in G-1 was accepted as the external standard (FLEISCHER 1965). Lead concentrations in other U.S.G.S. rock standards based on this value of G-1 are given in Table 1 with standard deviation calculated from a number of repeated runs. The uncertainty in the recommended lead value of G-1 is considerable. If future work should indicate a different value, the data in Table 1 should be changed by a factor  $X/49$ , where  $X$  is the new value for G-1. DOE *et al.* (1966) determined 30.8 ppm Pb in G-2 by isotope dilution, which, by our technique, would indicate  $45.8 \pm 0.5$  ppm Pb in G-1.

Table 1.

*X-ray spectrographic lead determinations in U.S.G.S. rock standards and syenite (Sy-1)*

a. based on 49 ppm Pb in G-1									
	G-1	W-1	G-2	GSP-1	AGV-1	BCR-1	PCC-1	DTS-1	Sy-1
		7.4	32.9	60.7	36.2	15.5	8.7	8.9	386.9
b. based on 30.8 ppm in G-2									
	G-1	W-1	G-2	GSP-1	AGV-1	BCR-1	PCC-1	DTS-1	Sy-1
	45.8	6.9		56.9	33.8	14.5	8.1	8.3	362.3
Std. dev.	1.2%	14%	1.2%	1.3%	1.4%	7.3%	13.3%	13.2%	0.3%

Table 2.  
Pb in feldspars (ppm)

Sample No.	Locality	Optical spec. HEIER & TAYLOR (1959)	Optical spec. X 1.81	X-ray (Std. dev. as indicated in Table 1 Spec.
36	Fevik granite .....	21	38	47.8
37	Fevik granite .....	28	51	51.0
39	Fevik granite .....	19	34	60.3
47	<i>Small pegmatite vein</i> Oddernes.....	17	31	82.0
	<i>Large pegmatites</i>			
50	Karlstad, Kragerö .....	3.0	5.4	4.6
51	Karlstad, Kragerö .....	4.9	8.9	10.8
52	Lindvikskollen, Kragerö	2.0	3.6	5.3
53	Lindvikskollen, Kragerö	n.d.	n.d.	7.0
54	Tangen, Kragerö .....	n.d.	n.d.	7.7
55	Tangen, Kragerö .....	n.d.	n.d.	6.8
56	Gloserhei, Arendal.....	n.d.	n.d.	7.3
57	Gloserhei, Arendal.....	n.d.	n.d.	4.7
58	Gloserhei, Arendal.....	n.d.	n.d.	5.8
60	Hinnebu, Aust Agder ..	39	71	117.6
61	Lauvrak, Aust Agder ..	54	98	96.6
62	Lauvrak, Aust Agder ..	50	90	127.7
72	Eretveit, Iveland.....	39	71	115.3
73	Eretveit, Iveland.....	42	76	116.9
74	Tuftan, Iveland .....	97	176	254.9
77	Heia, Iveland .....	60	109	169.4
78	Knutten, Iveland .....	95	172	136.2
79	Uranium mine, Iveland .	92	167	252.5
83	Ås, Evje .....	42	76	54.4

## Results

The lead contents of these feldspars published by HEIER & TAYLOR (1959) are given in column 1, Table 2. These emission spectrographic results were based on an assumed value of 27 ppm Pb in G-1, not stated in their paper but given in HEIER (1960), and will all be low if a value of 49 ppm is correct for this standard. Our working curve relating concentration to intensity was linear and this data can be amended by multiplying by the factor  $49/27 = 1.81$ , column 2, Table 2. The X-ray spectrographic data are given in column 3. The amended spectrographic data are in better agreement with the X-ray data. There is a general order of magnitude agreement between the two sets of data, except for sample 47.

The conclusions reached by HEIER & TAYLOR (1959) are substantiated by the newer data. The wide range of lead contents in potassium feldspars from pegmatites is verified. The feldspars examined here range from 5 to 250 ppm Pb, a factor of 50. The low Pb content of the feldspars from pegmatites in the Kragerö-Arendal district (Nos. 50-58) is noteworthy. It may reflect the higher regional metamorphic grade and deeper crustal origin of the rocks in this area (BARTH 1935, TAYLOR & HEIER 1958).

## REFERENCES

- AHRENS, L. H. & TAYLOR, S. R. 1961. *Spectrochemical Analysis*. 2nd ed., Addison Wesley, 454 pp.
- BARTH, T. F. W. 1935. The large pre-Cambrian intrusive bodies in the southern part of Norway. *Report XVI Int. Geol. Congress*, Washington, 1933.
- DOE, B. R., TATSUMOTO, M., DELEVAUX, M. & PETERMAN, Z. E. 1966. Isotope dilution determination of five elements in the reference sample G-2 (granite) with discussion of the analysis of lead. *Jour. geophys. Res.* (in press).
- DOE, B. R. & TILLING, R. I. 1966. The distribution of lead between coexisting K-feldspar and plagioclase. *Trans. A.G.U.* 47, p. 205 (abstract).
- FLEISCHER, M. 1965. Summary of new data on rock samples G-1 and W-1, 1962-1965. *Geochim. et Cosmochim. Acta* 29, 1263-83.
- HEIER, K. S. 1960. Petrology and geochemistry of high-grade metamorphic rocks on Langöy, Northern Norway. *Norges geol. Undersök.* 207, 246 pp.
- HEIER, K. S. 1962. Trace elements in feldspars — a review. *Norsk geol. Tidsskr.* 42 (Feldspar volume), 415-54.

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- HEIER, K. S. & TAYLOR, S. R. 1959. Distribution of Li, Na, K, Rb, Cs, Pb and Tl in southern Norwegian pre-Cambrian alkali feldspars. *Geochim. et Cosmochim. Acta* 15, 284-304.
- NORRISH, K. & CHAPPELL, B. W. 1966. X-ray fluorescence spectrography; In J. ZUSSMAN (ed.), *Physical Methods in Determinative Mineralogy*. Academic Press, London.
- TAYLOR, S. R. & HEIER, K. S. 1958. Alkali elements on potash feldspar from the pre-Cambrian of Southern Norway. *Geochim. et Cosmochim. Acta* 13, 293-302.

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