

COMPOSITION AND CLASSIFICATION OF CHROMITES IN THE FISKENÆSSET ANORTHOSITE COMPLEX

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Chromite compositions from about 30 different localities throughout the whole of the Fiskenæsset region were studied in detail with the microprobe. The samples were selected on the basis of Cr-Fe X-ray fluorescence analyses on chromite concentrates of 183 samples (Ghisler, in press) and after examination of a large number of polished sections. They are considered as presenting the complete composition range within the area. For a detailed presentation of methods and results the reader is referred to Ghisler (in press). Here only the main results are given of the composition of chromite in terms of the elements Cr, Al, Fe and Mg, which are necessary for their classification. Ten grains were assayed within each polished section, based upon measurements at several points in each grain. The results presented below are thus based upon the composition of about 300 grains, with a total of about 1000 point analyses.

Histograms of fig. 29 show the composition of 33 chromite samples from the anorthosite unit. The Cr₂O₃ contents vary from 25.8% to 44.1% (weight %) with an average of 35.1% Cr₂O₃. The Cr content is rather constant throughout the area with 87% of the samples between 30.1% and 39.0% Cr₂O₃. The Al₂O₃ contents are much more widespread ranging from 4.9% to 25.8% with an average of 18.6% Al₂O₃. The Fe₂O₃ content (calculated from total iron, based on the assumption that the ratio RO: R₂O₃ components is equal to 1), varies considerably from 6.7% to 32.6% with an average of 13.4% Fe₂O₃. The RO components are strongly dominated by iron FeO lying constantly around the mean of 29.4%, ranging from 25.5% to 33.2% FeO. The MgO content is very low throughout the area with an average of 3.5%, ranging from 0.3% to a maximum of 6.5% MgO.

The bulk composition of two chromites analysed from ultramafic host rocks are somewhat richer in Al and Mg, but fall in approximately the same field of composition. These chromite occurrences are of little importance quantitatively compared to the chromite deposits associated with anorthosite.

Graphical presentation of composition of minerals belonging to the spinel group is difficult as so many elements may enter the lattice. For the relative importance of the main elements occurring several graphical methods have been proposed. Stevens (1944) describes the spinel triangular prism of composition for the major elements Cr, Al, Fe and Mg, but for comparative purposes triangular diagrams are more useful. The molecular ratio of the RO and R₂O₃ components are calculated, and the resulting formula according to Thayer's (1946) method are found. The different norm compositions of the chromites are plotted in a chromite – spinel – magnetite triangular diagram (fig. 30).

For the chromites originating from anorthosites the majority of the values fall according to Stevens' (1944) classification into the field of aluminian chromite (24 samples), a minor

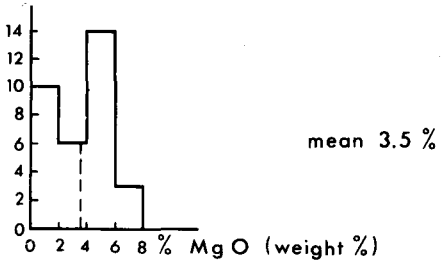
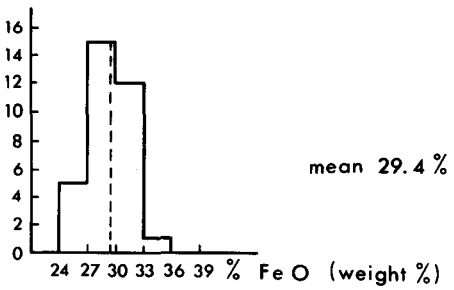
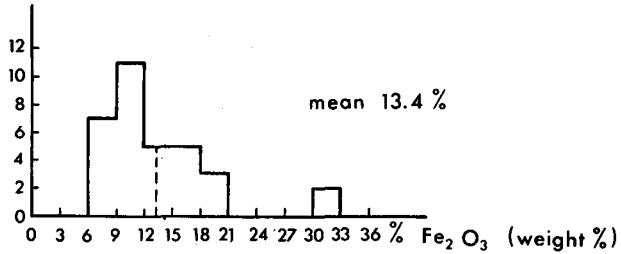
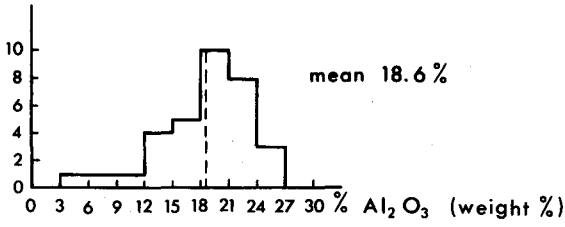
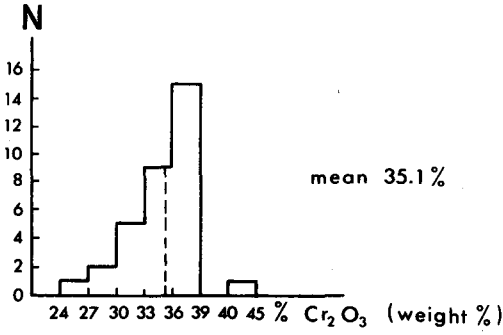


Fig. 29. Histograms showing composition of 33 chromites from anorthositic host rocks, Fiske-næsset. N = number of samples.

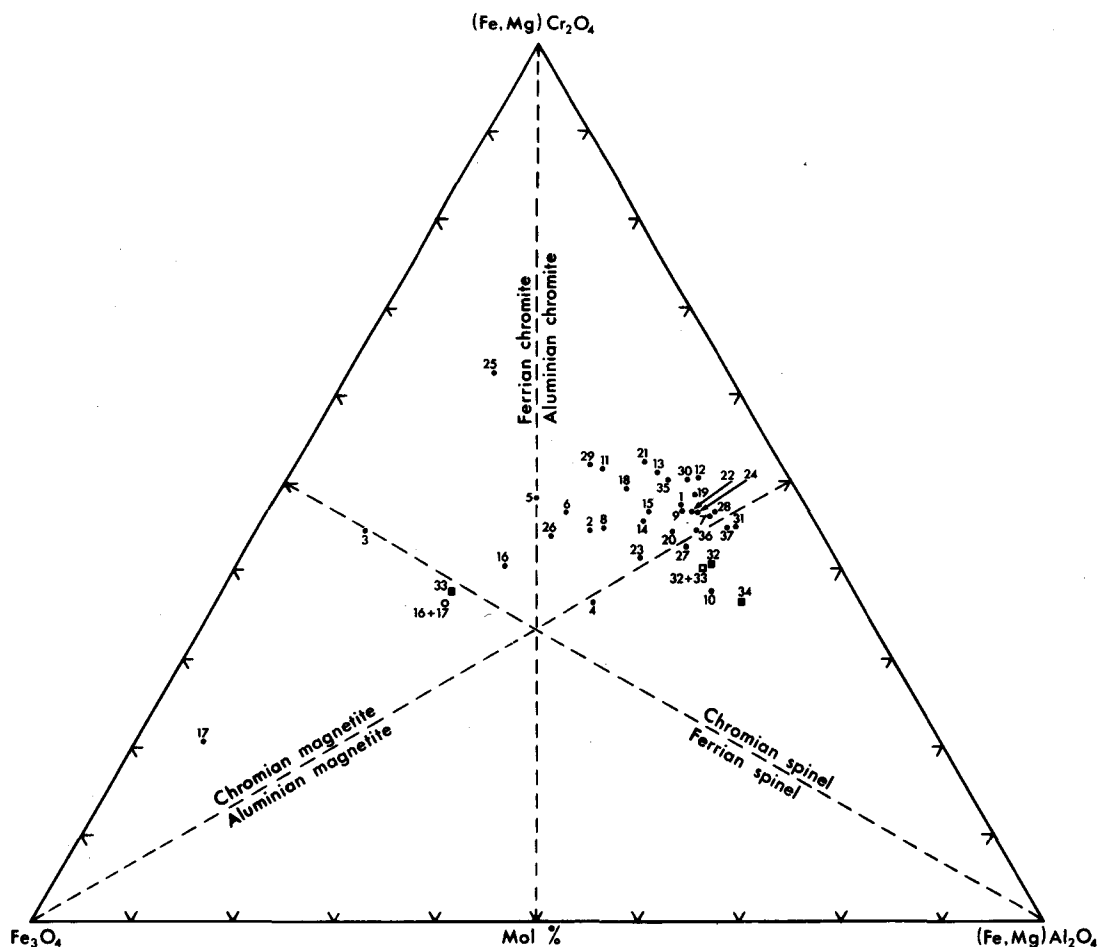


Fig. 30. Chromite-spinel-magnetite triangular diagram, showing the norm composition of the Fiske-nasset chromites (R_2O_3 components).

group into the field of chromian spinel (5 samples), whereas chromian magnetites and ferrian chromites are represented by three plots each. One sample consisted of two phases, the host ferrian chromite (no. 16) and an exsolved more iron rich chromian magnetite phase (no. 17). The bulk composition is indicated 16 + 17.

The bulk composition of the two chromites from ultramafic rocks are both classified as chromian spinel (no. 34 and 32 + 33). The latter consists of a chromian spinel host (no. 32) with exsolutions of chromian magnetite (no. 33).

The diagram (fig. 30) shows only the relative amounts of the R_2O_3 components. The $MgO/FeO+MgO$ molecular ratios vary considerably, from Mg_1Fe_{99} to $Mg_{48}Fe_{52}$. For the chromites originating from anorthosites the maximum Mg content corresponds to $Mg_{31}Fe_{69}$; the average of the 33 samples investigated (from anorthosites) may be expressed by the following formula:

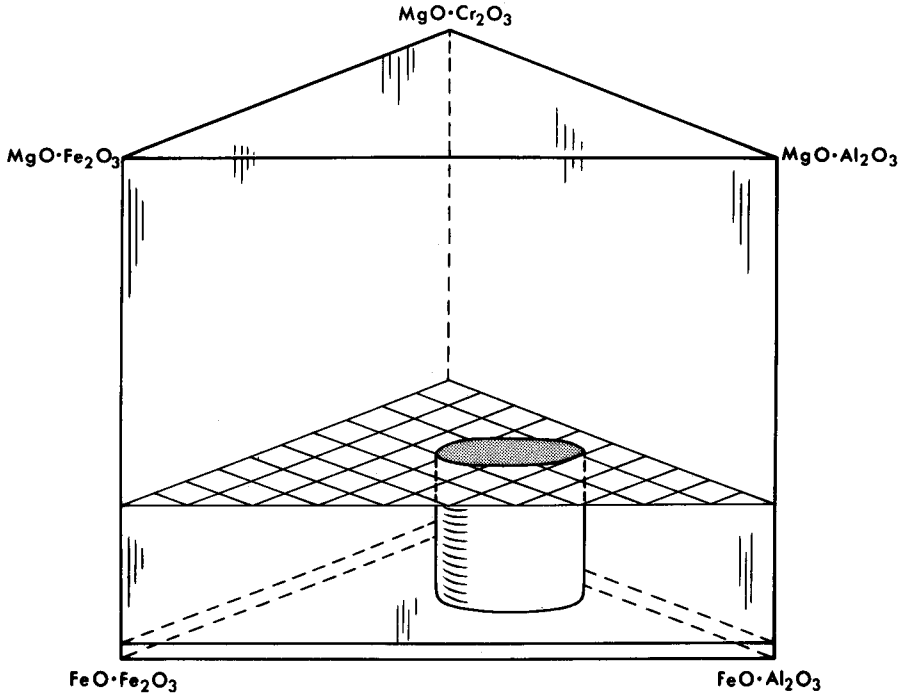
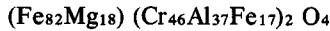


Fig. 31. Spinel triangular prism of composition, showing the position of the main portion of the Fiskensæset chromites.



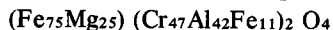
or in the means of norms:

(Fe, Mg) Cr ₂ O ₄ (ferrochromite)	46.5%
(Fe, Mg) Al ₂ O ₄ (hercynite)	36.6%
Fe ₃ O ₄ (magnetite)	16.9%

In fact the terms given represent the pure end members, which is not strictly correct in this case, but as Fe really dominates the RO group, these terms seem reasonable.

An attempt is made to illustrate the composition of the Fiskensæset chromites from anorthosites in the triangular prism (fig. 31). Neglecting the few samples of strongly deviating composition, they fall within a cylinder at the lower part of the prism.

Recent detailed investigations have shown that the primary Fiskensæset chromites partly recrystallised during several phases of folding and regional metamorphism (Ghisler, in press). The degree of recrystallisation varies from place to place and mainly depends upon the extent of stretching or flattening of each horizon. The recrystallised chromites may show distinctly lower contents of aluminium and magnesium and slightly lower Cr contents, whereas they are often considerably enriched in iron. The compositions of samples in fig. 30 accordingly only partly represent the primary chromites. The average composition of the pre-orogenic chromites corresponds to the formula:



The composition of the Fiskenæsset chromites indicates that they represent a significant new type among the major occurrences of this mineral throughout the world. Weiser (1966) investigated 214 chromite samples from 35 different deposits by microprobe. His results are shown in fig. 32 together with the results of the present investigation. The Fiskenæsset chromites (30 samples) plot into an area where none of Weiser's representatives are found. Only very few published chromite analyses plot within this field (Weiser, 1966, p. 62). Examples are chromites from the Red Mountain deposits, Kenai Peninsula, Alaska (Stevens, 1944) which occur in peridotite and have been contact metasomatized by an augite-hornblende dyke (Guild, 1942). Altered chromites from Barramia, Egypt, (Amin, 1948) show similar R_2O_3 norm composition, but MgO here completely dominates the RO components. Further examples are known from Maryland (Shannon, 1926) and from Wankur, India. The latter, a small folded chromite lens in "a country rock of hornblende schist and gneiss" of Precambrian age (Sarma, 1960), is of very similar composition to the Fiskenæsset chromites. But all these deposits are either small and not very well known or completely different from the Fiskenæsset one with respect to host rock

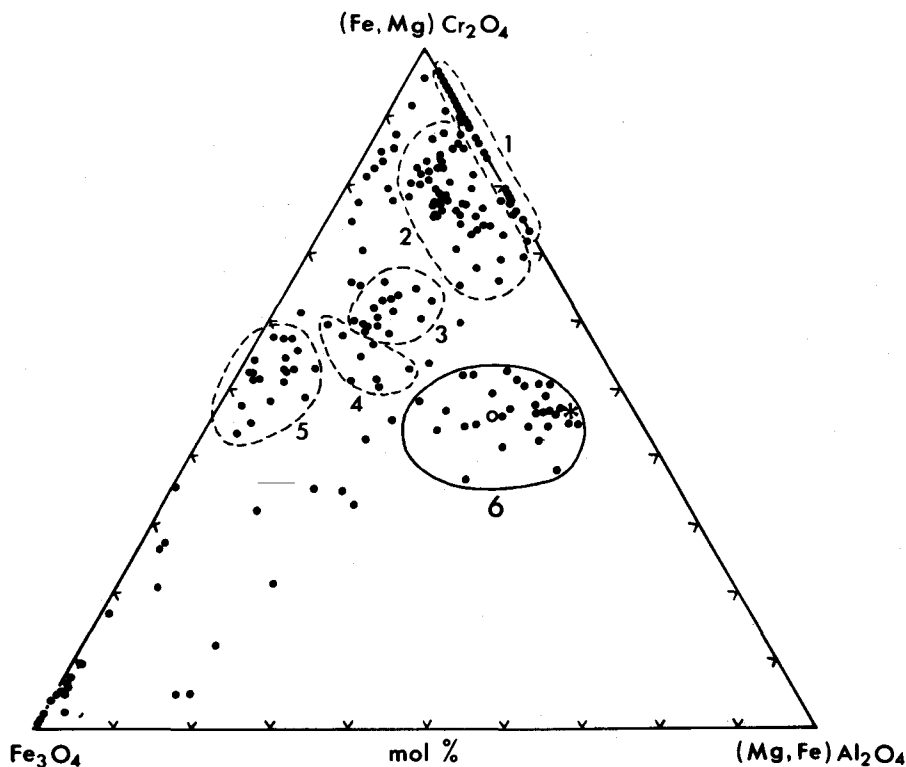


Fig. 32. Provinces of chromite deposits, based on the present analyses from the Fiskenæsset region and on microprobe investigations by Weiser (1966).

1. Southern Europe and Asia. 2. Bushveld Complex and Great Dyke. 3. Chromites from Bushveld Anorthosites. 4. Kemi (Finland). 5. Western Norway. 6. Fiskenæsset. ★ Sittampundi. ○ average Fiskenæsset chromites.

relations. A few chromite samples from the Anorthosite Series of the Bushveld complex (Cameron, 1964) show comparable compositions, but from fig. 32 it is seen that chromites from this series forms a special field (field 3) that does not overlap the Fiskenæsset compositional field.

The only very similar chromite from a deposit of major size is represented by one single assay of chromite from the Sittampundi complex, Madras India (Subramaniam, 1956, p. 354), which plots (fig. 32) within the Fiskenæsset field of composition, and is expressed by the formula:



It is seen that the R_2O_3 values are nearly identical with the composition of the primary Fiskenæsset chromites, whereas the Sittampundi one shows a little higher MgO content.

The Fiskenæsset chromite deposits occur as persistent stratigraphic horizons in anorthosite, traceable along strike for more than 200 km covering an area of 4000 km². They are thus typical stratiform type deposits, which however, show only weak affinities in chemistry to other major stratiform chromites (Irvine, 1967). The Fiskenæsset chromites are relatively rich in aluminium and iron and poor in chromium and magnesium. The genetic and chemical aspects of the Fiskenæsset chromite deposits are so characteristic and different from other major chromite deposits in the world that it seems reasonable to introduce the term 'Fiskenæsset type', as suggested by Ghisler (1970).

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