MINERALOGY AND PETROLOGY OF SOME CHROMITE ORES IN THE EASTERN DESERT, EGYPT

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Note

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Besides the research work materialized in this thesis, the candidate has attended ten, one - semester, post- graduate courses in the school year 1986/1987 in the following topices

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ABSTRACT

Detailed petrographic, mineralogical and geochemical studies of the chromite deposits at El Galala and Abu Dahr areas were carried out using X-ray fluorescence, DTA, microprobe studies and chemical analyses.

This study revealed that the main mineral constituents are chromite and magnetite. The gangue minerals are mainly antigorite, chlorite, talc, dolomite, calcite, lizardite and magnesite.

The cell edge of the chromite has been determined in the different deposits and was found to range from 8.254 to 8.295 A.

Chemical analyses indicate that the chromite is mainly Al chromite having a general formula $(Mg,Fe)(Cr,Al,Fe)_2O_3$.

The microprobe analyses reveal that the altered chromit is mainly ferrian chromite, thus indicating that no new phases are formed during the alteration processes, but mainly leaching of Al and Mg.

In the light of the data obtained the original of the ore is discussed.

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Introduction

INTRODUCTION

The chromite series normally includes numbers of spinel group in which the most dominate trivalent ion. The theoretical composition of chromite (a spinel group mineral) is $Fe^{2+} Cr_2 O_4$. This composition is only approached in chromite found in meteorites. Chromite is more accurately referred to as an isomorphous solid solution of continuously variable composition $(Fe^{2+}Mg)(Cr,Al,Fe^{3+})_2O_4$. Consequently the physical and chemical properties of chromite from different deposits and even within a single deposit may vary widely. The spinel group consists of the series of minerals with the general formula (AB_2X_4) (where A= Mg,Fe^{2+},Zn,Mn,Ni - B=Al,Cr,Fe^{3+},Mn^{3+},V,Ti - X=O), the spinels [$(Mg,Fe^{2+},Zn,Mn)(Al,Fe^{3+},Cr,Mn^{3+},V,Ti)_2\ O_4$], the magnetites [$(Fe^{2+},Mg,Zn,Ni)(Fe^{3+},Al,Cr,Mn^{3+},V)_2O_4$] and the chromites [$(Fe^{2+}, Mg)(Cr,Al,Fe^{3+})_2O_4$] with each of the minerals containing a number of well defined mineral varieties. There is a complete miscibility of components within series but much less between series, pure end members are rarely found. The spinels do not commonly show wide variations in the B part of the formula. The series is incompatible with quartz. Mineral species names are designated by the predominante divalent and trivalent atoms, and the substitutional varieties by the next most common constituents in order. In the minerals of spinel group there are 32 oxygen ions and 24 cations in the unit cell. The oxygen atoms lie approximately in cubic closest packing. The eight A atoms are in fourfold coordination between a tetrahedral group of oxygen atoms, and the sixteen B atoms are in sixfold coordination between an octahedral group of oxygen, In turn, each oxygen atom is linked with three B atoms and one A atom. Two structural types occur, differing in their distribution of cations among the A and B positions and known as normal and inverse spinels with general formula $R''_8\ R'''_{16}\ O_{32}$. The two types are normal $8R^{2+}$ in A, 16 R^{3+} in B and inverse $8R^{3+}$ in A, $8R^{2+}$, $8R^{3+}$ in B. Chromite ($Fe^{2+}Cr_2O_4$) forms a series with magnesiochromite ($MgCr_2O_4$) and hercynite ($FeAl_2O_4$). Magnisochromite usually contains some Fe^{2+} substituting for Mg, with additional substitution it grades to ferrian magnesiochromite, the most common variety and then to chromite. Aluminian magnesiochromite has Al substituting for Cr with a usual increase in Mg content. Addionally, Fe^{3+} can substitute for Cr giving a ferrian magnesiochromite, where the majority of the members of the chromite series have Mg > Fe^{2+}. The Mg bearing variety is the normal chromite and the end member $Fe^{2+}Cr_2O_4$ should be called ferrochromite. Most Cr-bearing spinels also contain a small amount of SiO_2 and traces of other components such as Mn, Ti and Ca.

PREVIOUS WORK:

It must be pointed out that most of the geological work that has been carried out on the Egyptian chromite deposits was concentrated mainly on the central part of the Eastern Desert especially at Barramiya district and that little attention had been given to the southern part of the desert. About seventeen occurrences of chromite are located, among these are Barramiya, Ras Shait, Abu Dahr, wadi El Ghadir, Umm kabu, Umm khriga, Sul Hamed, Wadi Seffine and other areas Fig.1 Several authors had discussed the chromite ores in Egypt. Among whom, Hume(1937) located three main segregations at Wadi Abu Ghurdi area near G.Abu Dahr. There have been three forms, the first deposit consists of four lenses, and one vein, the second deposit is a segregation of about 6 feet and an exposure of 25 feet, while the third deposit is the smallest occurrence. Ibrahim (1942) located few occurrences of chromite segregation in the Barramiya area, and classified them into three categories, grab or nodular forms, at Ras Salatite, with about 47.5% Cr_2O_3, big segregation (0.5-3 m) with about 49% Cr_2O_3, and a big lense south of the Barramiya gold mine (7-11 m) with about 40% Cr_2O_3. Ibrahim and Attia (1948) in benefeciation report of Barramiya mineral deposits grouped all the occurrences into nine sites. Amin (1948) studied three occrrences of chromite in the Barramiya district and Ras El Salatite, which have mainly lenticular bodies aligned east west or north east-south west. The alteration of chromite was due to magmatic and hydrothermal fluids causing decrease in alumina and magnesia and increase of ferric iron and a small amount of ferrous iron. Gad (1952) studied the chromite ore of some lenses occurring in the Barramiya district, chemically, microscopically, X-ray and by means of differential thermal analysis. This study revealed that the chromite have low SiO_2 content (about 3.02%) and give two endothermic peaks, one at about 700 to 750 degrees centegrate due to the loss of the water of constitution of silicate inclusion (chlorites) and the second at about 900 degrees centegrate caused by the loss of CO_2 from the carbonate impurities. Amin et al (1953) describing the geology of Atud district, recorded the presence of small chromite lenses (0.7-1m) among the antigorite _ chlorite schist which forms together with serpentine a small roof pendant in the granite mass close to Urf El Faid. El Shazly and Hamada (1954) described a number of sack form chromite lenses mainly in the ultramafic masses of peridotite origin. Mansour and Bassiouni (1954) reported twenty two chromite lenses in serpentine, talc carbonate rocks at Wadi Garf district, which ranged from 60 cm to 4.8m, with Cr_2O_3 ranging from 27.6 to 67.9 %. Moustafa and Abdalla (1954) recorded some occurrences of chromite bodies in the Abu Mireiwa district in the centeral Eastern Desert enclosed in serpentine and talc carbonate rocks. The smallest one is 1.3 X 1.1m while the largest is 17.7 X 0.7m. El Ramly and El Far (1955) in a report on the geology of Mueilha - Hagar Dungash areas, described a group of lenticular chromite bodies, at eight sites in the main serpentine range, mostly in talc carbonate rocks, the Cr_2O_3 varies from (25.43 to 46.57%). Amin (1955) recorded some minor chromite occurrences at Um El Rus within the serpentine mass running along the contact of the green schist and yellow tuff stones east of Bir Um Khariga. Sabet and Zatout (1955) in a report dealing with the geology of El Shalul El Bakriya district described two small chromite lenses (maximum length one meter) within antigorite mass at the head of Tila Godalla. Mansour, Bassiouni and El Far (1956) recorded the presence of two chromite lenses on the northern slope of G.Um El Salatit where the Cr_2O_3 content is about (42.23%), and Fe_2O_3 (about 18.36%). Hunting Geology and Geophysical company (1967) in a study of the mineral potentials of Aswan region organized by the Regional Planning and Development program of Aswan region mentioned the presence of chromite at Abu Dahr, Dungosh and Wadi Ghadir. Zohny (1967) studied the geochemistry of chromites from Wadi El Rubsh, Barramiya, Wadi Ghadir, Wadi Arais, Wadi Ekwan, and Wadi Allaqi. The author distinguished between two types of chromites, a high silica type, e.g chromite of Wadi Ghadir, Rubsh, and Arais, and a low silica type in the three other localites. The ore in all the occurrences with the exception of that of Arais was described as magnesium aluminian chromite, while Arais ore was magnesian ferrian chromite. Basta and Hanafy (1970) in their study of the alteration of some Egyptian chromite came to the conclusion hat, the alteration process is attributed to two stages of late magmatic stage and an autohydration or hydrothermal stage