MINERALOGY OF THE IRON ORE DEPOSITS OF WADI KAREIM AND SOME OTHER OCCURRENCES IN THE EASTERN DESERT, EGYPT, U.A.R.

Thesis submitted to

Faculty of Science
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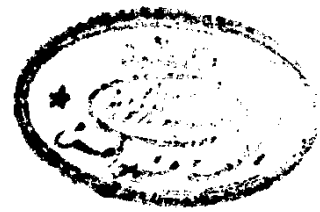

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CONTENTS

CHAPTER I

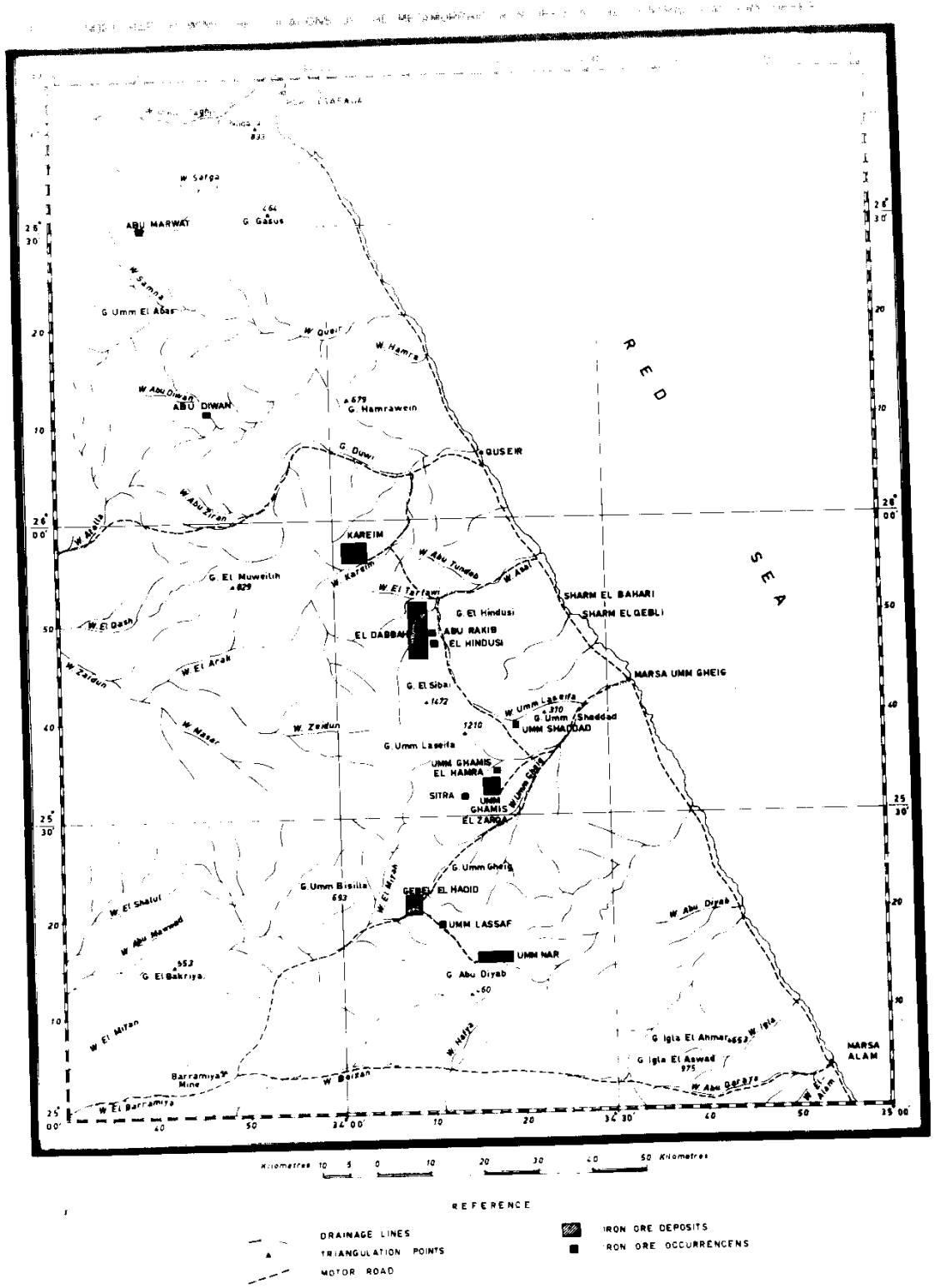
INTRODUCTION

(1) Location of Wadi Kareim area.

Within the basement rocks of the Eastern Desert, some banded iron ore seams and lenses are found, which occur conformably with the schist-mudstone-greywacke' series presumably of Middle pre-Cambrian age (Akaad,1959). The metamorphic iron ore deposits, so far discovered are thirteen deposits and occurrences. In magnitude the deposits may reach up to seven kilometers in length and two kilometers in breadth. The recorded deposits are distributed over an area covering about 85 X 35 km^2.

The iron ore deposit of Wadi Kareim lies on the northern side of Wadi Kareim at its junction with the northerly tributary of Wadi Umm Heyut and to the south-west of Quseir (Fig.1). The south-eastern extremity of the deposit covers an area of 2.75 square kilometers and lies between Longitudes 34° 01' and 34° 04' East, and Latitudes 25° 56' and 25° 58' North.

The Kareim deposit forms an elevated country with a number of isolated peaks which have altitudes ranging from 307 to 507 meters above sea level. The deposit was potentially subdivided by the German geologists (1959) into the western, the central fields and the eastern massif.



(2) Scope of the present work.

The main object of this work is to give the results of a detailed investigation of the mineralogy of Wadi Kareim iron ores and their conditions of formation. A comparative study of the mineralogy of the iron ores in Abu Marwat area have been carried out to correlate them with those of Wadi Kareim. The petrography of the iron-bearing formation was given a great deal of care, as it reflects many of the geological events that took place during the sedimentation, and later metamorphism of the pre-Cambrian iron ores. A special attention was given to the massive magnetite bodies, their mineralogy, chemical composition and genesis.

Samples representing the different iron ores and their country rocks were subjected to detailed mineralogical and petrographical investigations. About 100 samples were collected from the outcropping ore seams, bore holes K-6 and K-7. Examination of adits number 2 and 4 was carried out with the aim to elucidate the mode of occurrence of the massive magnetite bodies and their paragenetic relations with the pre-Cambrian iron ores.

The different samples have been examined in both thin sections and polished surfaces. Complete chemical and semi-quantitative spectrographical analyses of the pre-Cambrian banded iron ores and the massive magnetite bodies are given to corroborate the microscopic investigations. An attempt has been made to explain the conditions of formation of the pre-Cambrian iron ores, and the possible genesis of the massive magnetite bodies in Wadi Kareim.

(3) Review of previous work.

The first discovery of the pre-Cambrian iron ores in the Eastern Desert was by Ferrar in 1907 (Hume, 1935) who recorded the occurrence of an iron ore band at Wadi Siwiqat Umm Lassaf which later was given the name of Gebel El-Hadid. Around 1924, the deposit of Wadi Kareim was discovered by local Arabs. During 1930 - 1931 the Quseir Phosphate Company carried out detailed topographical and geological mapping of the Kareim deposit aiming at exporting the ore. During 1948 - 1949 S. Afia and S. Nasser of the Mineral Research Section, Department of Mines carried out considerable field studies on the deposit. In course of these studies a topographical

map was prepared to the scale 1 : 2500 on which was located about 333 iron ore bands (Fig. 2). Detailed sampling and measurement of the different bands as well as estimation of the ore reserves (2.5 million tons) of proved ore were carried out. Finally chemical analyses of 47 channel samples was undertaken.

Attia (1950) briefly described Wadi Kareim iron ores and considered them as weakly metamorphosed pre-Cambrian beds alternating with other sedimentary series. He gave one chemical analysis and quoted sevefal analyses for the ore. Nakhla (1954) described some polished surfaces of the ore showing it to be of magnetite partly altered to martite with quartz as chief gangue and rare goethite. El-Shazly (1957) considered the iron deposits of Wadi Kareim, Umm Shaddad, Umm Ghamis, Wadi Siwikat Umm Lassaf and Umm Hagalig as pre-Cambrian metamorphosed sedimentary deposits. Gindy (1957) studied the succession of the pre-Nubian sandstone rocks around the phosphate mining district of Quseir, and correlated them with Wadi Kareim and other areas. He mentioned that the rocks of Wadi Kareim consist mainly of highly alternating series of graded-bedded siltstones, greywackes, breccias, mud-stones, greenstones and a thick series of slates. These

rocks are intersected by dykes of porphyrites, andesites, dolerites, gabbros and trachyandesites. The whole country rocks were then variably deformed, sheared and regionally metamorphosed. They were intruded by high level diapir-like granitic intrusions. Besides, he mentioned that hornfels aureoles (chiefly epidote-amphibolite and amphibolite facies) surround these high level plutons, and that the main country rocks outside these contact aureoles are in the greenschist facies. Concerning the iron ores, Gindy (op. cit.) described them briefly and is in favour of their sedimentary origin though he mentioned the mechanism responsible for their formation is open to discussion. Gindy further concluded that the iron ores of Wadi Kareim area might have been originally derived from the weathering of basic igneous rocks and that a clastic origin is very unlikely. The coarse-grained calcite veinlets and lenses were attributed by the same author to late hydrothermal activity.

Akaad (1957) noted that the iron bands found in the western field and the southern half of the eastern massif of the deposit are massive and occasionally interbedded with thin bands of jasper. While the ore seams found in the northern half of the eastern massif are interbedded with ochreous, calcareous, and uncommonly

jasper bands. El-Ramly and Sabet (1958) reviewed the metamorphic iron ores of the Eastern Desert. They made a general study of the deposits of Wadi Kareim, El-Dabbah, Umm Shadad and Wadi Umm Nar. These authors considered the ores of Wadi Kareim as metamorphosed magnetite-hematite interbedded with bands of chlorite schist.

Sigaev (1959) considered the metasedimentary series of Wadi Kareim as forming an anticlinal structure, and that the iron seams belong to two different horizons which are observed in the eastern massif. The lower part of the first horizon is found in the centre of the anticline which continues all over the area for about 2.75 kilometers from east to west. Sigaev estimated the thickness of the first horizon as about 200 meters. In the north, this horizon is exposed on the surface, while the second one was eroded. The second or upper horizon is found only in the eastern massif of the area. It is separated from the lower one by a succession of " mud-stones " ranging in thickness from 100 to 200 meters, and consists of 6 or 7 iron bands with an extension of about 600 - 700 meters. These bands pinch out towards the centre and are replaced by " mudstones " and silty argillites poor in ore bands.

The Fried Krupp Konstruktionen Germany (1959) considered the iron ores of the Kareim area as being formed by submarine exhalations and that the ores were deposited in " the usual sedimentary fashion " within a greenstone series consisting of volcanic rocks of the diabase and keratophyre type and intercalated sediments (schists, quartzite, ... etc). They distinguished four major iron seams, irregularly stratified and exhibiting a considerable thickness (1.5 to 12 m). The following ore types have been recognized : 1) reddish violet jaspilitic ore, 2) essentially black, mostly magnetite ore, and 3) yellowish-brown and dark banded carbonate bearing ore. This latter type represents variation in facies of the jaspilitic ore.

Akaad (1959) considered the iron ores of Wadi Kareim as metamorphosed hematite-magnetite bedded ores which represent original sedimentary iron bands in a greywacke' - mudstone series of pre-Cambrian age. He also differentiated between some of the relic marks of early sedimentation textures and structures and later diagenetic structures. El-Ramly (1961) made a comparative study of the different iron deposits of the Quseir area, concerning the country rocks, mode of occurrence, mineralogical and chemical

characters. He also considered the ores of sedimentary origin occuring as a series of bands intercalating conformably different members of the schist-mudstone-greywacke series.

(4) The pre-Cambrian of the Eastern Desert.

Several workers previously studied the basement complex of the Eastern Desert of Egypt. Among these workers may be mentioned, Barron (1902), Blanckenhorn (1910), Ball (1912), Barthoux (1922), Hume (1934, 1935), Ibrahim (1941), El-Shazly (1957), Schürmann (1957), Akaad and El-Ramly (1960) and others.

Hume (1934 and 1935) considered the basement rocks as being most probably of pre-Carboniferous age, observation based on that the youngest rocks overlying the basement complex contain fossil remains of Carboniferous age. Barthoux (1922) recorded incomplete calcareous skeletons (fragments of Holothurian) in one occurrence of the Hammamat conglomerates, considered by Hume (1935) as the first example of the pre-Cambrian fauna in Egypt.

Blanckenhorn (1910 - 1921) studied the pre-Cambrian in the northern extension of the Gulf of Aqaba and considered Middle and Upper Cambrian sediments overlying rocks very similar to the Hammamat conglomerates. A new occurrence of Cambrian fossiliferous sandstones in the north-eastern end of the Dead sea was described by King (1923). These sediments unconformably overlie rocks, nearly similar to the Hammamat conglomerates. These formations were later proved by Picard (1943) to extend from the North Eastern Desert through Sinai and into Jordan.

Broadly speaking, the pre-Cambrian rocks of Egypt were classified by Hume (1935), Ibrahim (1941), Schürmann (1953, 1961), Amin (1955), El-Shazly (1957, 1964), Akaad and El-Ramly (1960) and Sabet (1961). Hume's classification is given in Table I.

Ibrahim (1941), made a comparative classification of pre-Cambrian rocks of Egypt with those of the Canadian shield.