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GEOLOGY OF GACHERI DHORO BARITE DEPOSIT, LASBELA, PAKISTAN

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ABSTRACT

Barite alongwith sulphide minerals occurs at several places in the southern part of axial fold belt of Pakistan. The deposits are confined within a lower-middle Jurassic rock sequence consisting of medium thick bedded limestones alternating with shales. In Lasbela area, allochthonous mineralized Jurassic blocks are embedded in a melange belt consisting of serpentinized ultramafics, doleritic sills and spilitic lava flows. Gacheri Dhoro deposit comprises of about 20 meters thick mineralized zone of interbedded limestone, shale and baritic rock. The precipitation of barite has taken place in the Jurassic sediments at structural highs by circulating connate brines or by mixing of meteoric water with ore fluids during late diagenetic-epigenetic stage of the host rock.

INTRODUCTION

Barite deposits in Pakistan are located at several places within the well defined tectonic unit known as Axial Belt. Most important deposits occur around Khuzdar where reserves are estimated as 1.5 million tons and a grinding plant for barite has recently been set up. Several deposits are known in Lasbela District but only two have briefly described by KLINGER and ABBAS [1963]. The barite occurrence at Gacheri Dhoro, known for quite sometimes and quarried on a small scale in the past, has not been described before.

Gacheri Dhoro, a perennial stream originating from Mor Range and flowing to the plains of Lasbela, is on Survey of Pakistan Topo-sheet No. 35.J/12. The deposit can be reached from Uthal which is 125 km north of Karachi on R.C.D. Highway. From Uthal a jeepable track follows the stream bed for 40 km and ends up at a ridge whose peak is locally known as Bhuji (838 m). The deposit is located about 200 m below the peak. The terrain is rather rugged and rock types of widely varying nature impart a high relief to the area.

REGIONAL GEOLOGICAL SETTING

Major tectonic activity during late Cretaceous-Tertiary has shaped the fundamental geologic structures of Pakistan. The most dominant among them is an axial fold belt which runs sinuously throughout the country from north to south. This fold belt is the result of northward movement of the Indian plate and its subsequent collision with the Afghan and Central Iran blocks of the Eurasian plate [POWELL, 1979]. The northern part of the fold belt shows southward thrusting, varied grades of metamorphism and anatectic granitic intrusions. The Central and southern part of the fold belt appear to be generally devoid of these features since the northward movement of the Indian plate after collision appears to have been absorbed by the Chaman transform system of faults. However, a number of ophiolitic occurrences with varying thicknesses of melange are conspicously present all along the belt near the western boundary of the Indian plate.

The Lasbela region constitutes the southern part of the fold belt and consists of well defined north-south running Pab and Mor ranges, and less defined Jaisar and Kulri ranges *(Fig. 1)*. Mor Range forms the structural high and is the most prominant geomorphic feature of the area. The range is composed of Jurassic limestones succeeded by the Cretaceous formations on the flanks. A stack of thrust sheets consisting of ophiolitic rock lies over Cretaceous argillaceous strata west of Mor Range. The ophiolitic sheet is composed of more or less thoroughly serpentinized ultramafic rocks, thick gabbroic-doleritic sills and spilitic pillow lava. The ultramafics are mainly harzburgite with minor dunites, periodites and chromitites. The sills and flows are intercalated with a varied assemblage of sediments such as radiolarian cherts, siliceous argillites, shales, marls and limestones. Manganiferous and cupriferous sediments are also present locally. In between the Cretaceous argillaceous sequence and the allochthonous ophiolites is a narrow belt of sedimentary melange. The melange belt named as Kanar melange (DeJong and Subhani, 1979] is made up of blocks which vary in size from a few tens of metres to over a kilometre and are set in a variegated pelitic matrix. The blocks consist of ophiolitic and Mesozoic, mainly Jurassic, shelf rocks of the area.

The oldest rocks exposed in the Lasbela area represent the lower-middle division of Jurassic as in other parts of the fold belt (Table 1). The unit is named Windar

Table 1

Mesozoic succession of the southern part of axial belt

Emplacement of Bela ophiolite in Paleocene		
CRETACEOUS	UPPER	PAB SS.
		PARH LS.
	LOWER	GORU FM.
		SEMBAR FM.
JURASSIC	UPPER	
	MIDDLE	
	LOWER	SHIRINAB FM.

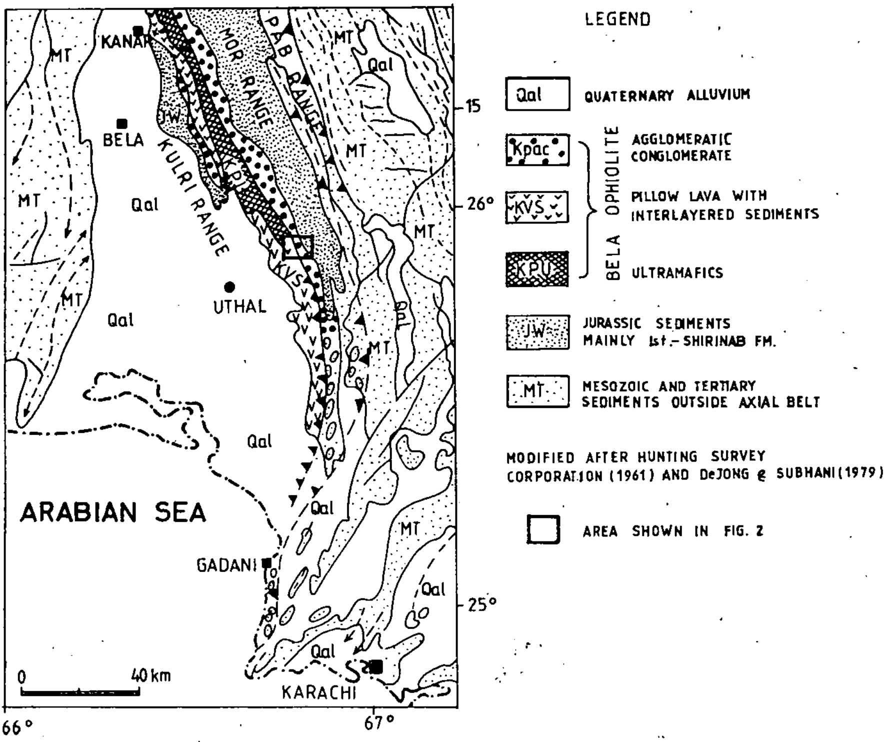

Fig. 1. Geological map of southern part of axial belt (Lasbela region)

group by Hunting Survey Corporation [1961] and Shirinab formation by FATMI [1977]. The formation dominantly consists of medium to thick bedded limestone with subordinate dark calcareous shales. The thickness of the formation is measured more than 1500 meters in the Mor Range.

A monotonous sequence of regularly bedded brownish gray, finely laminated mudstones with thin intercalations of shale and marl overlies the Jurassic rocks. The strata are deformed by open flexural folding. The sequence has the stratigraphic position and lithology of Sembar formation though it does not display the characteristic greenish hue and abundance of belemnite. The maroon shales and limestones of Goru formation are not seen in the area.

The argillites are overlain by volcanic rocks with interflow shales and ultramafics. The volcanic rocks consisting of a heterogenous assemblage of pillow basalts, radiolarian cherts, argillites and manganese bearing sediments are named as Bela Volcanic group by Hunting Survey Corporation [1961]. The ultramafics and doleritic sills were considered to be intrusive in nature and were named as "Porali Intrusions". The volcanics and ultramafic bodies are now interpreted as obducted oceanic crust. The ultramafic slivers are taken as a part of layer 4, pillow basalts with dolerite sills as layer 2 and radiolarian cherts with manganese bearing sediments as layer 1. Layer 3 of gabbro sheeted dykes is not known in the area but has been reported in the adjacent area (SUBHANI, pers. comm). A typically intact sequence has not been observed either in the area under study or in the adjoining Kanar Area [DeJong and Subhani, 1979]. The partial sequences met in the area meay even be reversed. According to Alleman [1979] the obduction has taken place in Paleocene.

GEOLOGY OF THE DEPOSIT

A barite quarry is situated at an elevation of about 600 m where work has been done on two levels along the strike of the beds. In the upper working level 4 m thick beds have been opened for 25 m along the strike while the lower working level exposes 14 m thick beds for 56 m in the strike direction. The section shows half to one meter thick limestone beds, alternating with shale beds having intercalation of thin limestone bands. Barite-sulphide mineralization is confined to limestone beds. The thicker beds of limestone are more intensively mineralized as compared to thinner beds which contain a number of stringers and lenticles. These layers and stringers lie parallel to the bedding. The details of the section exposed in the lower level of the quarry and the extent of mineralization is shown in *Fig. 3*. Some late fractures 2—5 cm thick and oblique to the bedding are filled wiht slightly greenish coloured and granular barite. However, such fractures are confined to a single thick bed and do not cross the underlying or overlying beds.

Barite is transluscent, clear to milky white with well developed elongated basal cleavage. Crystalline aggregates of barite often display a radiating structure; the rosettes of barite are well developed where thick mineralization has taken place, though it can be descerned even in the stringers. Cubes of galena about one inch size are frequently observed in the limestone in association with barite.

Assuming the ore body to be tabular, a highly conservative estimate of the reserves is calculated on the basis of exposed quarry sections. The estimate is 1500 tons for the upper level and 12 000 tons for the lower level. The reserves are expected to be more since the mineralized beds have not been opened fully in their strike direction as the overburden increases appreciably for an open cut. Similarly one may expect more mineralized beds below the lower most unmineralized shale bed. Nevertheless, the quarrying has been abandoned as it proved to be unprofitable. Most of the barite, apart from two continuous layers, is in the form of stringers and can only be recovered from the limestone by crushing and hand sorting.

Two samples of barite (BG—1 and BG—2) from the richly mineralized 2.1 metres thick bed of limestone and one (BG—3) from less mineralized limestone bed below, have been analysed. The analyses of Khuzdar main barite [Klinger and Ahmed, 1967] are also given for comparison (Table 2).

The Jurassic rocks containing the mineralized beds and forming Bhuji peak is an allochthonous block resting over the Cretaceous strata *(Fig. 2)*. The Lasbela region displays a compressional tectonics and the presence of ultramafics are explained by thrusting. An obvious explanation for the presence of Jurassic block over the younger strata would be overthrusting of older rocks towards east. Moreover, role of gravity tectonics as an active process during initial emplacement of the rocks appears significant.

The reversal of the ophiolitic sequence may be due to isoclinal and recumbent folding [Abbas, 1979]. A complete intact sequence, however, has not been observed in the area and the reversal of partial ophiolitic sequence in Kanar area, Lasbela District has been compared with "diverticulation" in Alps [DeJong and Subhani, 1979] and are shown to be indications of emplacement by gravity. The mechanism

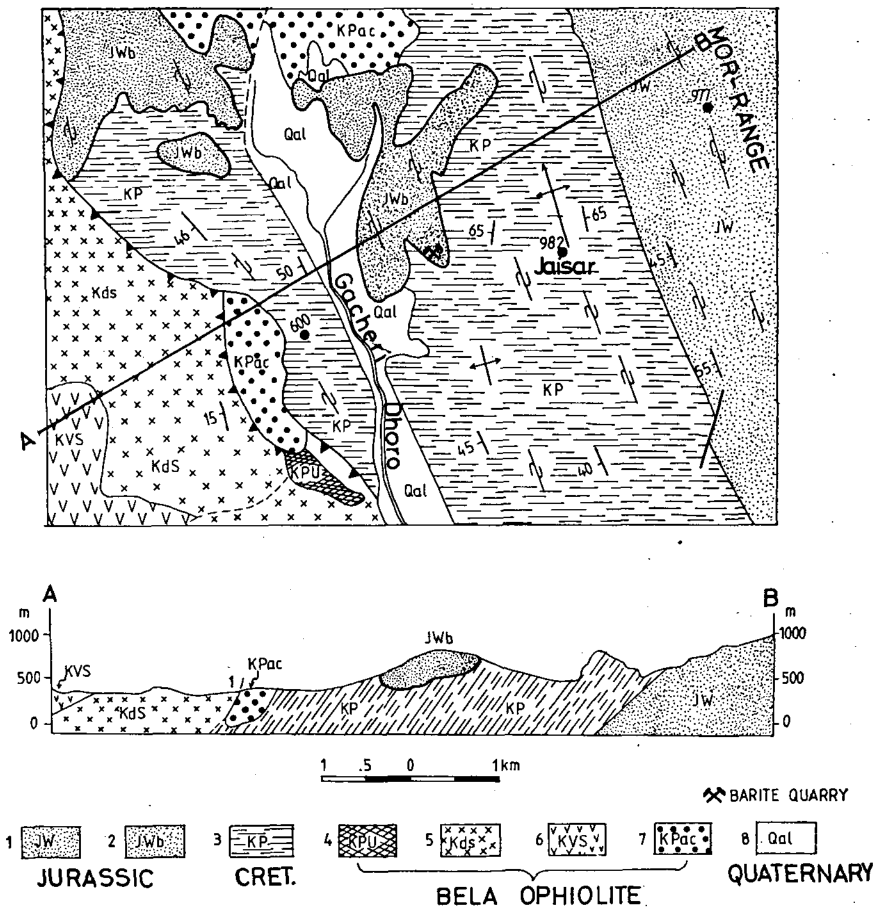

Fig. 2. Geological map of Gacheri Dhoro area, Lasbela. Legend: see *Fig. 1*

is envisaged as beginning with the uplifting of the source area and sliding of the upper layer followed successively by lower layers resulting in a reversal of the sequence. For gravitational emplacements it is sufficient that the upper surface of the cover material slopes in the direction of the displacement [HUDLESTON, 1977]. The Mor uplift provides the necessary slope where gliding under gravity would cause a reversal of the ophiolitic sequence as well as the emplacement of the Jurassic blocks on Cretaceous volcano-sedimentary sequence between Kulri Range and Mor Range. The Jurassic blocks are much more defor medthen the surrounding mudstone and conglomerate. The discrepancy between the structural style clearly indicates a prior deformational history of the blocks before their final emplacement.

ORIGIN OF THE DEPOSIT

In Khuzdar area, barite deposits are known from Gunga, 16 km south of Khuzdar. The deposits extend for 1200 metres in length in Jurassic limestones and consist of barite lenses varying in thickness from 3 to 6 metres in the south to 15 metres in

TABLE 2

Analysis of barite samples

CONSITUENTS %	BG—1	BG—2	BG—3	Ba—1	Ba—2
	SAMPLE NOS.				
$BaSO_4$	97.86	95.34	63.76	91.86	95.92
SiO_2	0.07	0.32	3.71	2.48	1.84
Fe_2O_3	0.05	0.13	0.14	0.02	0.03
Al_2O_3	0.37	0.38	2.11	2.73	0.26
CaO	0.70	1.75	12.10	0.98	0.49
MgO	0.00	0.13	3.65	1.91	0.76
Ignition loss	0.96	1.88	14.23	1.63	0.67
TOTAL:	99.99	99.93	99.70	99.62	99.97

NOTE
BG — 1 Barite samples from Gacheri Dhoro
BG — 2
BG — 3 Barite with limestone, Gacheri Dhoro
Ba — 1 Barite from Khuzdar main barite deposits
Ba — 2 [KLINGER and AHMED, 1967]

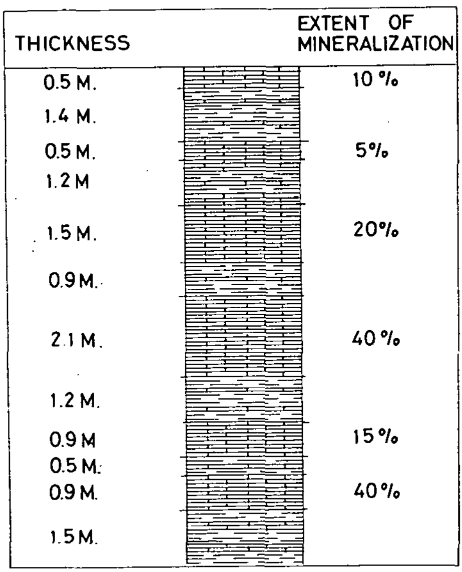

Fig. 3. Barite quarry section (lower level)

the north. Small amounts of calcite and quartz, minor amounts of goethite, haematite, and traces of galena, cerussite, cinnabar and rhodochrosite are associated with barite. Three kilometres further south, a porous gossan containing galena associated with pyrite and traces of copper is an extension of the barite horizon. At Shekran, 25 kilometres northwest of Khuzdar, galena associated with siderite and limonite is known to occur in the same horizon. Minor occurrences of barite and fluorite are also reported from Shekran.

In Lasbela area, barite deposits are reported from Kundi, Bankhri and Siro Dhoro. At Kundi, 65 kilometres north of Bela, barite occurs in a 8 metres thick zone in Jurassic limestone. The barite zone consists of alternating layers of barite and dark gray fissile shales. Thickness of barite layers vary from 0.3 to 1.5 metres. Association of galena and traces of copper minerals are often observed. The Gacheri Dhoro and few smaller barite deposits in Kulri Range occur in allochthonous Jurassic blocks emplaced in volcano-sedimentary sequence of lower Cretaceous.

The origin of the stratiform barite bodies in carbonate rocks can be explained by preferential replacement of certain favoured beds along bedding planes. The deposits have generally been considered to belong to an epithermal suite precipitated from low-temperature hydrothermal solutions [KLINGER and AHMED, 1967; SCHEGLOV, 1969: ZAIDI, 1972]. In the absence of a nearby igneous source, the term telethermal has been used to indicate a distant source and a cooler nature of the solutions. SILLITOE [1975] relates the deposits to the precipitation by connate brines in Jurassic host rocks on the continental shelf of the Indian Plate prior to its seperation from Gondwanaland. The mixing of a barium rich circulating connate water with ascending telethermal solutions may account for deposition of barite [SAWKINS, 1966]. Ground water-ore fluid interface may also cause the deposition of barite as the solubility of barium in the ore fluid is considerably decreased on coming in contact with meteoric water [PLUMMER, 1971]. The laterally upward movement of pore fluids in the depositional basin due to compaction under the weight of overlying sediments has been suggested by JACKSON and BEALS [1967] for Mississippi Valley type ores.

A mechanism for the origin of stratiform barite bodies under discussion is suggested here. The telethermal solutions reach the northwestern shelf of Indian shield where the sediments are being laid down during Lower-Middle Jurassic period. The floor of the basin is marked by an uplift forming an elongated ridge which trends north-south. The subsequent movements lead to the emergence of ridge at many places to form intermittent island like areas along the whole length. The ore fluids move laterally upwards as a result of compaction under the weight of overlying sediments. The ascending ore fluids finally reach the structural highs in the basin where emergent Lower-Middle Jurassic limestones form island like areas. The mixing of ore fluids with meteoric water causes a marked decrease in the solubility of barium ions in the ore solutions and leads to the precipitation of barite. The role of barium-rich connate water trapped during early sedimentation stages can not be ruled out. The compaction of sediments during the late Jurassic period may expel the ore fluids to suitable sites such as bedding planes where barite is precipitated.

The stratiform nature of the deposits, their occurrence within a confined stratigraphic interval and insignificant wall rock alteration of the host rocks, suggest that the barite mineralization has taken place during the late diagenesis of Lower-Middle Jurassic sediments. The occurrence of barite nodules in the overlying Sembar formation at Naka Pabni also indicates that the mineralization has taken place before Late Jurassic — Early Cretaceous shales were laid down.

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