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STRATIGRAPHIC OBSERVATIONS OF LATERITES IN PAKISTAN AND OSCILLATION AND MOVEMENT OF THE EURASIAN AND INDIAN BLOCKS

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ABSTRACT

The laterite beds in Pakistan are found in isolated zones of outcrops but are spread over a wide area in the country. They can be divided stratigraphically into four age groups: Upper Devonian of Chitral district; Jurassic of Punjab and Baluchistan; Cretaccous-Paleocene of Punjab, Baluchistan and Sind; and Oligocene of Sibi. Laterites are also found as thin layers or ferrogenous coating in the Siwalik group of rocks.

The mode of formation of the laterites indicates conditions of sub-aerial weathering or oxidation. It has been observed that rocks rich in ferromagnesian minerals on oxidation gave rise to thicker beds of laterites having higher percentage of iron. Some interesting information regarding the movement of plates has been provided by these laterite layers when studied on regional scale.

INTRODUCTION

The laterite layers in Pakistan are found at a number of stratigraphic intervals. (Hunting Survey, 1960; Ahmad, 1969). Some of them are too limited in extent and thickness to merit any significance. However, a number of laterite outcrops, which in places seem to be bauxitic, are traceable for a considerable distance, e.g., in Sanjawi arch area and Salt Range. Laterite beds range in age from Devonian to Paleocene and even younger. The late Cretaceous-Paleocene laterites are the most widespread and are exposed in many places. Laterite beds are also associated with Nari limestone of Oligocene age in Nakus and Dera Bugti areas of Sibi District. Stratigraphically, the laterites of Pakistan are divisible in four age groups: upper Devonian, Jurassic, Cretaceous-Paleocene, and Oligocene, and are geographically well-spread. Very small and thin lenses of laterite are also noticed at various horizons of Siwalik group. The thickness of the laterite beds is

variable from place to place but those belonging to late Cretaceous and Paleocene are generally much thicker than the others.

It has been observed that the laterite beds have some relation with the movements of the plates in Pakistan.

GEOGRAPHICAL DISTRIBUTION

It appears that the laterization has taken place in areas of emergence and uplift during different geological periods. Such areas are scattered in almost all the four provinces of Pakistan. For their detailed description these occurrences have been grouped as follows :

I. 1. Reshun area of Mastuj valley, Chitral (Upper Devonian).

II. 2. Salt Range, Punjab, and
3. Sanjawi arch, Sibi and Loralai districts, Baluchistan (Jurassic).

III. 4. Muzaffarabad and Kotli areas, Azad Kashmir;
5. Hazara Division, NWFP;
6. Kala Chitta Range, Attock district, Punjab;
7. Salt Range, Jhelum, Rawalpindi and Mianwali districts, Punjab;
8. Samana Range, Kohat district, NWFP;
9. Sanjawi arch, Sibi and Loralai districts, Baluchistan;
10. Mal Thana area of Ras Koh Range, Chagai district, Baluchistan;
11. Lakhra area of Dadu district, Sind; and
12. Nagar Parker, Tharparker district, Sind. (These are Cretaceous-Paleocene in age).

IV. 13. Nakus area, Sibi district, Baluchistan, and
14. Dera Bugti area, Sibi district, Baluchistan. (These laterites are associated with Oligocene sediments).

STRATIGRAPHICAL DISTRIBUTION

Upper Devonian Laterite.

Laterite has been reported by Stauffer (1969) in the Shogram Formation of Upper Devonian age near Reshun in the Mastuj valley of Chitral (Fig. 1 I-1). The formation consists of limestone and calcareous sandstone. The laterite is massive, hematitic, fine-grained and in some places nodular. The thickness of the bed ranges from 2 to 6 meters. This bed is expected to continue in other areas of Chitral and Gilgit where this horizon is exposed but has not been fully explored.

Jurassic Laterites.

The laterization in Jurassic has taken place on the marginal areas of Jurassic basin, as in the case of the Salt Range. During Jurassic time it has also developed on the uplift now called the Sanjawi arch. Though the laterization does not seem very intense, it is quite widespread. It is easily detected in the field either by the presence of a ferrogenous bed or a ferrogenous coating on the upper surface of the pre-laterization starta along a disconformity. However, the disconformity in the

stratigraphic column of Jurassic seems to occur at different horizons and in different rock types at different places and so does the laterite bed.

Salt Range. In the Salt Range (Fig. 1 $_{2-1}$) the laterite lenses are associated with the Datta Formation. The laterite layers are generally thin but variable in extent, thickness and composition. They are intervened by lenticular bands of calcareous sandstone, shales, glass sand, fire clay, dolomite and carbonaceous material. In general the strata of the Datta Formation show reddish and brownish hue which indicates that as a whole it has either been deposited at surface or under shallow water conditions falling within the limits of zone of oxidizing environment.

Sanjawi Arch. In the Sanjawi arch area the laterite bed either lies directly below the Belemnite shale now named as Samber Formation (Fig. 1 $_{2-2}$) or, as seen at a few places, it occurs above the Chiltan Limestone within a band of about 2 m thickness consisting of pyritic siltstone, reddish-brown clay and argillaceous limestone with numerous Jurassic ammonites, intervening between the Chiltan and Belemnite shale. In this region this ammonite-bearing band with or without laterite has been seen at several places. (Fig. 1 $_{2-3}$). The maximum thickness of laterite bed noted in this area is about one meter.

Late Cretaceous-Paleocene Laterites.

This is the most widespread surface of laterization and is found in many parts of Pakistan. It is associated with the gentle upwarps of large extent such as those of the Salt Range, Kala Chitta, Punjab lateral uplift, Sanjawi arch, Lakhra uplift and Ras Koh high. In many localities, sediments belonging to Late Cretaceous and Paleocene are found mixed or intercalated with the laterite bands.

Muzaffarabad and Kotli area. In Azad Kashmir, as for example near Muzaffarabad, the laterite is found below the Tertiary and above the Permo-Carboniferous. It is the same horizon of laterization which occurs at the base of Tertiary in the Kala Chitta range and elsewhere. Due to overstepping it rests on different formations in different places in the northern region of Pakistan. Here the Tertiary strata are represented by marly limestone and carbonaceous shale, and the Permo-Carboniferous by the limestone and dolomite (Fig. 1 $_{3-1}$).

Hazara Division. In Hazara Division the laterite band has been located at many places, notably Garhi Habibullah, Langrial and Kakul. It occupies the same stratigraphic horizon as in Azad Kashmir. It lies below the Paleocene carbonaceous shale and limestone in the Langrial area (Fig. 1 $_{3-2}$). Almost similar is the position of the laterite band in the Kakul area.

Kala Chitta Range. In this range the laterite bed occurs below Lockhart Limestone and above Kawagarh Formation of Late Cretaceous age, and has the same age as that of Hazara and Azad Kashmir.

Samana Range. In Samana Range near Fort Lockhart on the road from Hangu Town, a bed of laterite attaining a thickness upto 4 m occurs within the upper

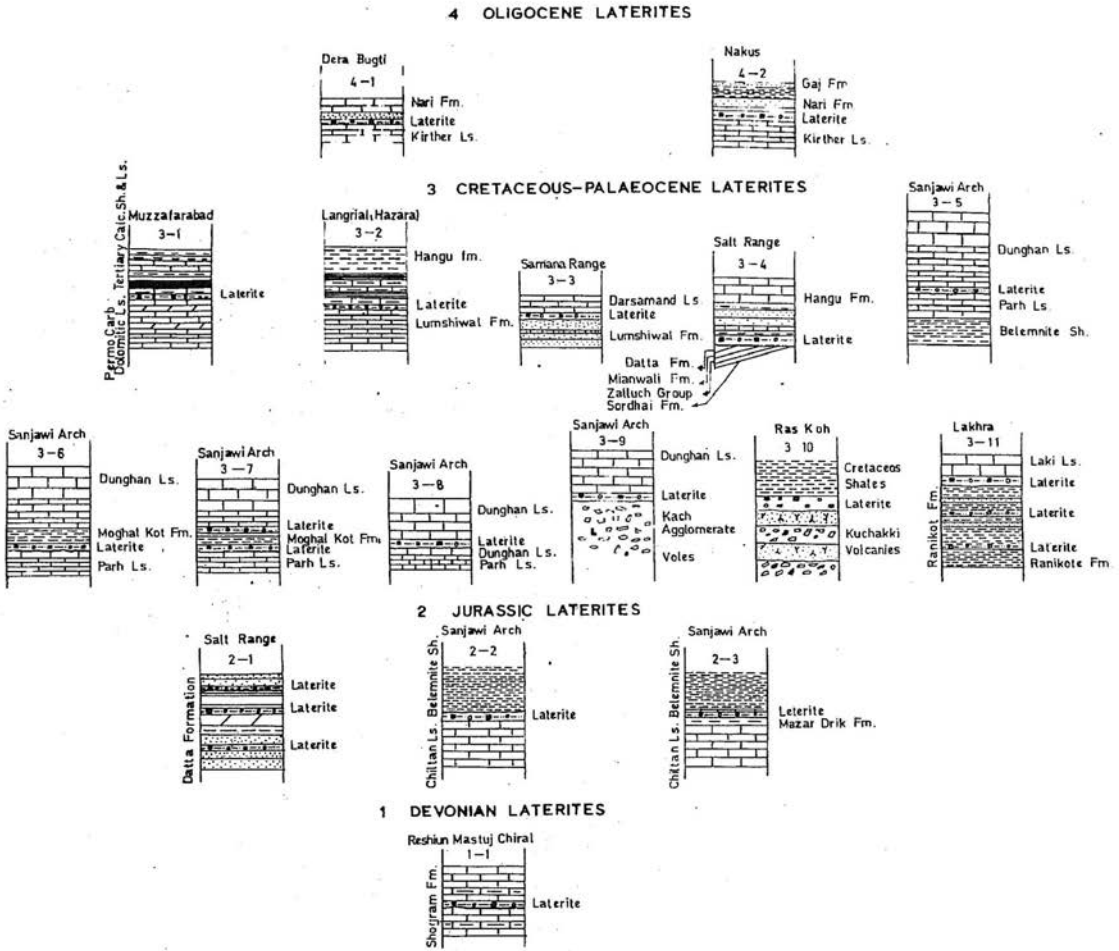

Fig. 1. Diagram showing laterite layers in stratigraphic columns of Devonian, Jurassic, Cretaceous-Paleocene and Oligocene rocks.

part of Lumshiwal Formation of Albian age (Fig. 1 $_{3-3}$). The Lumshiwal Formation here is overlain by Kawagarh Formation (Darsamand Limestone) of Late Cretaceous age. Among the Cretaceous horizons it seems to be the lowest in Pakistan.

Salt Range. All along the Salt Range, laterization has been noticed at the base of Dhak Pass beds which are of Early Paleocene age. From east to west the laterite bed oversteps younger and younger formations. As for example in Katha area south of Pail village in Sargodha District, the laterite bed is found resting on the Amb Formation, and to the west in Kathwai area it steps over the Chhidru Formation. Further west it is found over the Mianwali Formation. Towards east it downsteps lower and lower formations (Fig. 1 $_{3-4}$).

Sanjawi Arch area. In this area laterization is the most prominent, widespread and thickest, attaining a thickness of more than 16 m. The laterite bed extends from Sanjawi village in Loralai to the Kach area in Sibi. At places the laterite bed overlies the Parh Limestone and underlies the Moghal-Kot Formation of Late Cretaceous age. In one or two places the bed has been bifurcated with the shale member of Moghal-Kot Formation lying in between. Yet at other places the laterite bed is found resting on Parh Limestone and overlain by Dunghan Limestone of Lower Paleocene. The laterite bed is also seen above a band of limestone resembling Dunghan at some places. It also overlies the Kach volcanics in places. It seems that the period of laterization in this area ranges between the Late Cretaceous to Early Paleocene (Fig. 1 $_{3-5}$ to $_{3-9}$).

Ras Koh Range. South of the Mal Thana in the Ras Koh Range, a bed of laterite has been noticed lying over the Kuchakki volcanics. The laterite is overlain by a sequence of comb strata composed of shale, mudstone and sandstone of Late Cretaceous age (Fig. 1 $_{3-10}$). Above this lies Rakshani Formation (Paleocene) containing repeated thin laterite lenses interspersed in the lower part of its column.

Lakhra area, Dadu District. In the Lakhra-Jhimpir area the Ranikot Formation of Paleocene age has a number of laterite lenses starting right from its basal part and going up to its top (William, 1965). It seems that the whole formation was deposited in very shallow water conditions and at times was subjected even to subaerial weathering. At the close of the Paleocene period the area was subjected to an intensive and prolonged laterization which is marked by a thick bed of laterite at the top of the Paleocene formation over which lies the Laki Limestone of Early Eocene age (Fig. 1 $_{3-11}$).

Nagar Parker, Tharparker District. Lateritic lenses here are reported to occur below Tertiary and above Cretaceous rocks.

Oligocene (Nari) Laterites.

Along the tapering of Sibi high the sedimentation has been very much influenced by the oscillation of the Sibi basement wedge. This fact has been reflected in the nature of sedimentation along the periphery of the wedge and on its medial part itself. In some cases variation is seen both in thickness and

lithology. During Oligocene, this area was subjected to subaerial weathering, resulting in laterization as indicated by a bed upto 2 m thick. This phenomenon has given rise to laterization around this wedge examined at the following places (Fig. 1 [1-2], 2).

Nakus area. In this area dark brownish, yellowish, generally pisolitic laterite has been found associated with the Nari Formation. Above the Nari lies the Gaj, and in places the rocks are said to be of Lower Siwaliks (Fig. 1 [1-2]).

Dera Bugti area. North of Dera Bugti town, the laterite occurs in lower part the Nari Formation. The famous Bugti bone bed is also associated with laterite-bearing horizon.

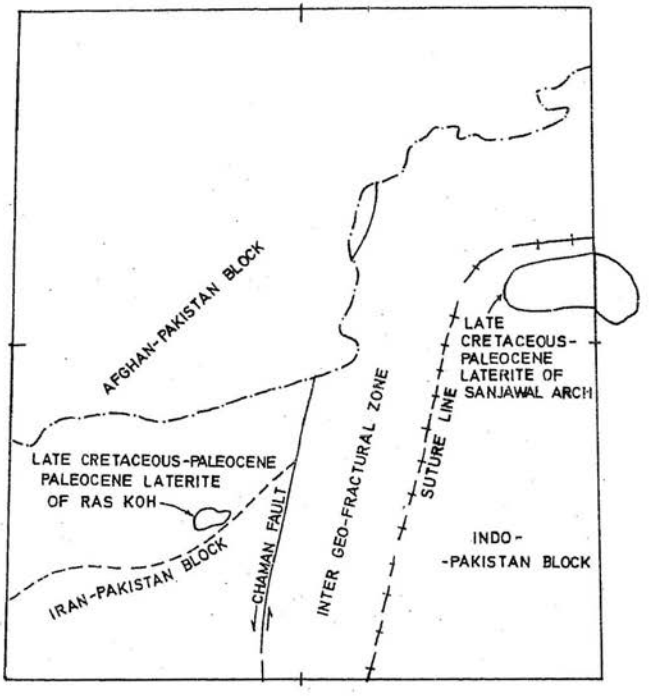

Fig. 2. Map showing the Late Cretaceous-Paleocene laterite on two sides of suture line.

LATERIZATION

The geological history of Pakistan indicates that laterization along major disconformities has taken place during Devonian, Jurassic, Cretaceous to Late Paleocene, and Early Oligocene. These periods experienced epiorogenic movements involving gentle upwarp and emergence of substantial track of land which came under favourable conditions for laterization. It is interesting to note that the region of Sanjawi arch area has experienced three periods of laterization. It indicates that tropical climate prevailed there from Late Jurassic to Early Oligocene or at least it was repeated intermittently during the three periods.

The laterization in Devonian has not been fully studied as it is found in a high and remote area of Hindu Kush range. It is, however, said that it is the fourth locality of the world from where Paleozoic laterization has been reported.

During the Late Cretaceous to Paleocene time again the Sanjawi arch, Salt Range, Kala Chitta Range, Samana Range and areas in Azad Kashmir emerged and came under laterization. Almost at the same time Lakhra, Ras Koh and other upwarped areas were subjected to laterization. During Oligocene, some areas falling on or situated along the margins of the wedges or protrusions of basement came under laterization because of intermittent oscillation of the wedges. The laterization in Oligocene time, e.g. in Nakus and Dera Bugti areas, and in Siwaliks along the Sibi wedge, are also due to this oscillatory process.

Another factor which facilitated the laterization is the nature and composition of rocks that came under subaerial weathering. Laterization during Late Cretaceous to Paleocene is the most widespread and prominent because easily susceptible rocks underwent laterization for a long period. The volcanics which are richer in Fe, Al, and Ti minerals, produced large laterite deposit in Sanjawi arch and Ziarat, providing a strong support to this opinion (Shah, 1960, 1965).

Laterization Surface in Relation to Plate Movement

Some interesting points emerge out of the study of these laterite beds. They throw some light on the movements and oscillation of the plates in Pakistan. The Devonian laterite which is now outside the tropical zone, i.e. north of 36° lat., indicates that the area in Devonian time was lying much south in tropical regime of weathering and has been subsequently pushed northwards with the Indian Plate.

The laterite found along the contact of Triassic and Jurassic in the western Salt Range is indicative of the fact that the Indian plate, soon after its detachment from Antarctica in the Triassic, came within the zone of tropical weathering which shows a movement of about 3200 km to the north. It also indicates that the rate of movement of this plate was greater in the beginning than afterwards if compared with the total distance it has travelled so far in time and space.

It is interesting to note that the Late Cretaceous-Paleocene laterite occurs on the same horizon and with same depositional environment on both the sides of suture line and Chaman fault in Ras Koh and Sanjawi arch (Fig. 2). It clearly indicates that the emergence of areas was simultaneous both on Indian and Iran-Afghan plates.

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