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The Speculative Role of Epeirogenic Movements in Oil Migration and Accumulation in Mesozoic Reservoirs of Sulaiman Fold Belt of Balochistan, Pakistan

S.H.A. Shah[1], M.U. Quadri[1], and H. Gulraiz[1]

ABSTRACT

The role of the epeirogenic movements in oil migration and accumulation in the Sulaiman fold belt has been speculated in the light of the evidence provided by the occurrence of subaerial surfaces of weathering and the oil seeps. The area and the horizons of emergence in the Jurassic and Cretaceous have been examined. The study has led to figure out the structures of the Chiltan limestone and the overlying formations before and after the Himalayan orogeny.

The oil migration and accumulation from the Sembar source have been depicted and the influence of the hydrodynamic force on the pools has been pointed out along with the recommendations for future exploration in the area.

INTRODUCTION

In the fold belt of Sulaiman region including Marri-Bugti areas a number of gas fields have been discovered in Mesozoic reservoirs of Late Cretaceous age. These fields are Pirkoh, Loti, Jandran, Rodho and Dhodak gas fields (Figure 1). However till now, except some condensate, no oil discovery has been made in this area though a number of oil shows and seepages are reported.

The field examination of the stratigraphic sections of the Mesozoic for oil exploration in the higher part of the fold belt indicates two major surfaces of subaerial weathering, one at the top of the Jurassic Chiltan limestone and the other on the top of Cretaceous Parh limestone where the formation of laterite has taken place. These surfaces because of their up-wraps also indicate the occurrence of epeirogenic movements. These movements have brought a vast area under sub-aerial conditions.

The Sembar shales are said to be the main source rock in the area. Wherever they came under sufficient load of the overlying formations they yielded oil. This oil was supposed to migrate upward and accumulate in the crestal area of the Epeirogenic arch. However, this arch might have been modified by the subsequent Himalayan orogenic movements.

The associated hydrodynamic regime established after these movements should have displaced the oil pools down the dip of the fold from anticlinal crest to its steeply inclined limbs in the direction of hydrodynamic forces.

AREA OF EMERGENCE

The approximate areas which came under subaerial weathering due to the emergence in Jurassic and Cretaceous times are large (H.S.C., 1961). Beside the substantial area which was exposed to subaerial weathering and where lateritic crusts had formed, there was a large area which did not come under subaerial conditions. This part of the epeirogenic highs however, let the oil migrate through it to the crests of the highs and wherever there was some superimposed local high (Figure 2) the oil might also have accumulated there.

HORIZONS OF EMERGENCE

The examination of the stratigraphic sections has revealed that there are a number of horizons of emergence marked by the layers of laterite or red colouration. However, there are only two horizons which are of obvious consequence for the migration and accumulation of oil. The first one is the top part of Chiltan limestone while the second one is the top part of the Parh limestone. The Parh limestone is overlain in some places by the Dunghan limestone, Mughal Kot formation or the Pab sandstone (Shah, 1977) etc. with patches of laterite in between at some areas.

OIL SEEPS

In the Sulaiman basin three prominent oil seeps in addition to bituminous shows occur (H.S.C., 1961). Two of

[1] Department of Geology, University of Karachi, Karachi, Pakistan.

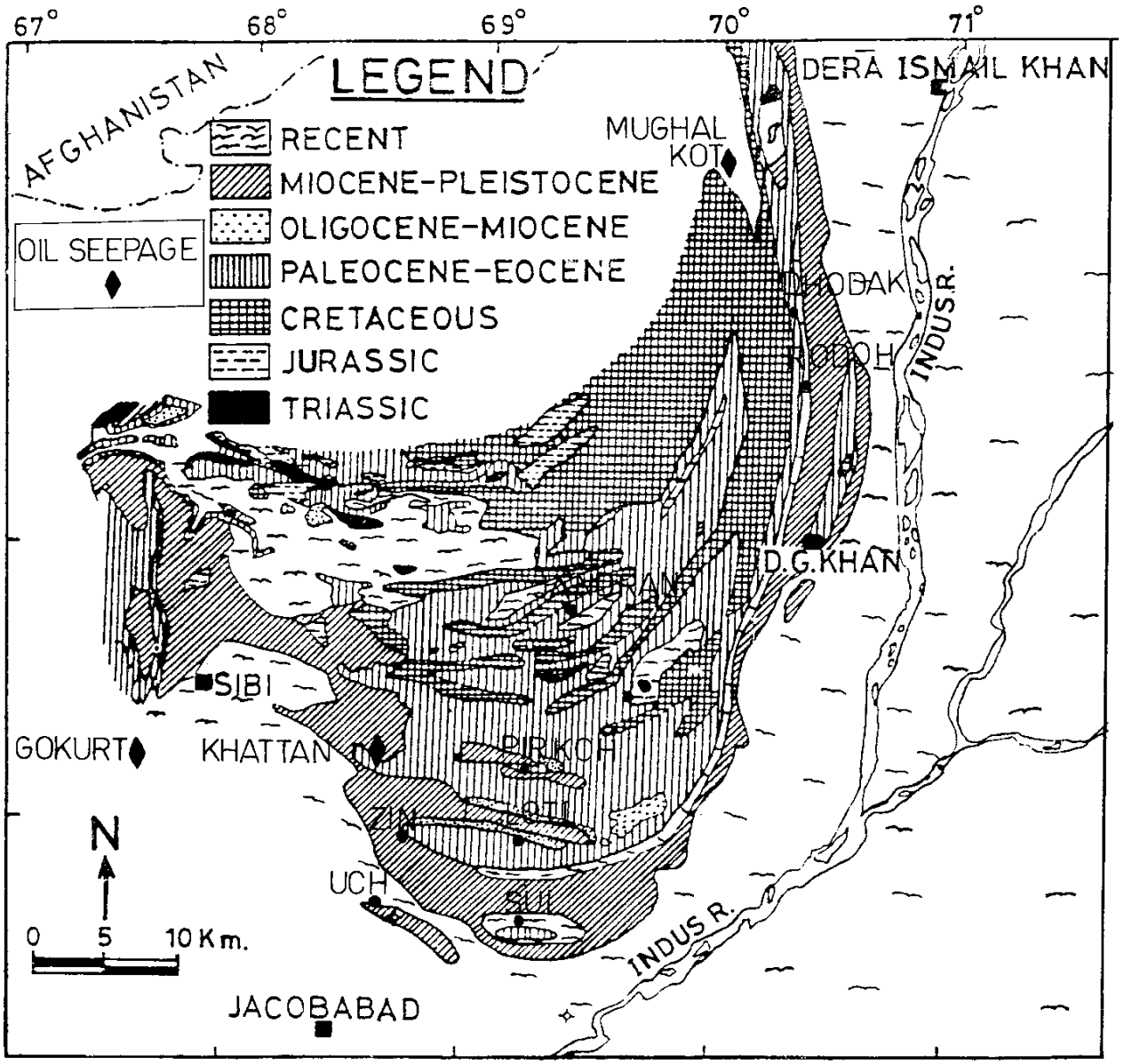

Figure 1— General geology and locations of seepages and gas fields in Sulaiman area (after Raza et al., 1989).

them are on the rim of Sibi trough while the third one is on the eastern flank of the Sulaiman mega-anticlinorium (Figure 1). A geological description of these seeps is as follows:

Gokurt Oil Seeps

These are situated in the lower part of Bolan Pass. The oil of these seeps is tarry. Inflammable gas also comes along with the oil. The seeps are supposed to occur along a fault. Some geologists believe that the oil comes from Jurassic limestone. However the situation is not satisfactorily clear.

Khattan Oil Seeps

These seeps are located about 40 miles east of Sibi in the Marri-Bugti Hills. This oil is thought to come from

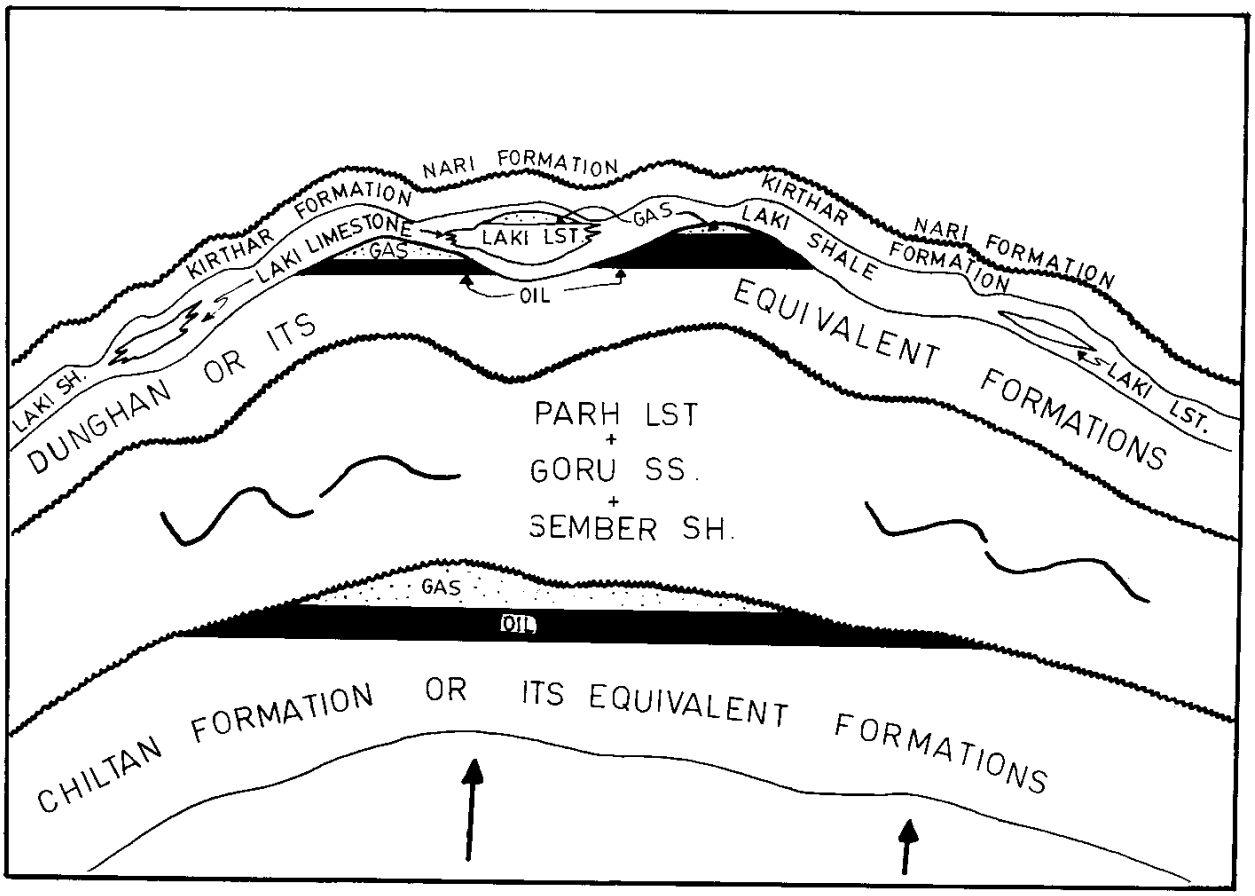

Figure 2— Pre-Himalayan (Epierogenic) structural configuration in Sulaiman region.

Dunghan limestone and the seeps are at its contact with Ghazij shale. The oil is black, viscous and tarry and associated with the springs of hot sulphurous water.

Mughal Kot Oil Seep

It occurs about two miles west of Mughal Kot fort. The oil of this seep is light yellow and looks like kerosene. It seems to come from the Pab sandstone. At Mughal Kot the gas does not appear to associate with the oil.

CONFIGURATION OF THE STRATA LYING OVER TOP OF THE JURASSIC CHILTAN LIMESTONE

A regional study of the surfaces of the Jurassic Chiltan limestone and the Cretaceous Parh limestone leads to speculate on the general epeirogenic structure of these surfaces. A diagramatic sketch of the same (Figure 2) shows that there were some broad crestal highs where the oil had accumulated before the Himalayan orogeny. It was later modified to its present form as diagramatically shown in Figure 3. This is obviously a speculation but the stratigraphic setting, geological history and the occurrence of the oil seeps in the area reasonably suggest the situation depicted in the diagrams.

CONCLUSION AND RECOMMENDATIONS

It is possible that the hydrocarbons became available for primary migration from their source in Sembar shales when they came under sufficient overburden to generate the oil.

The hydrocarbons might have started migrating again (secondary migration) updip the epeirogenic arch before

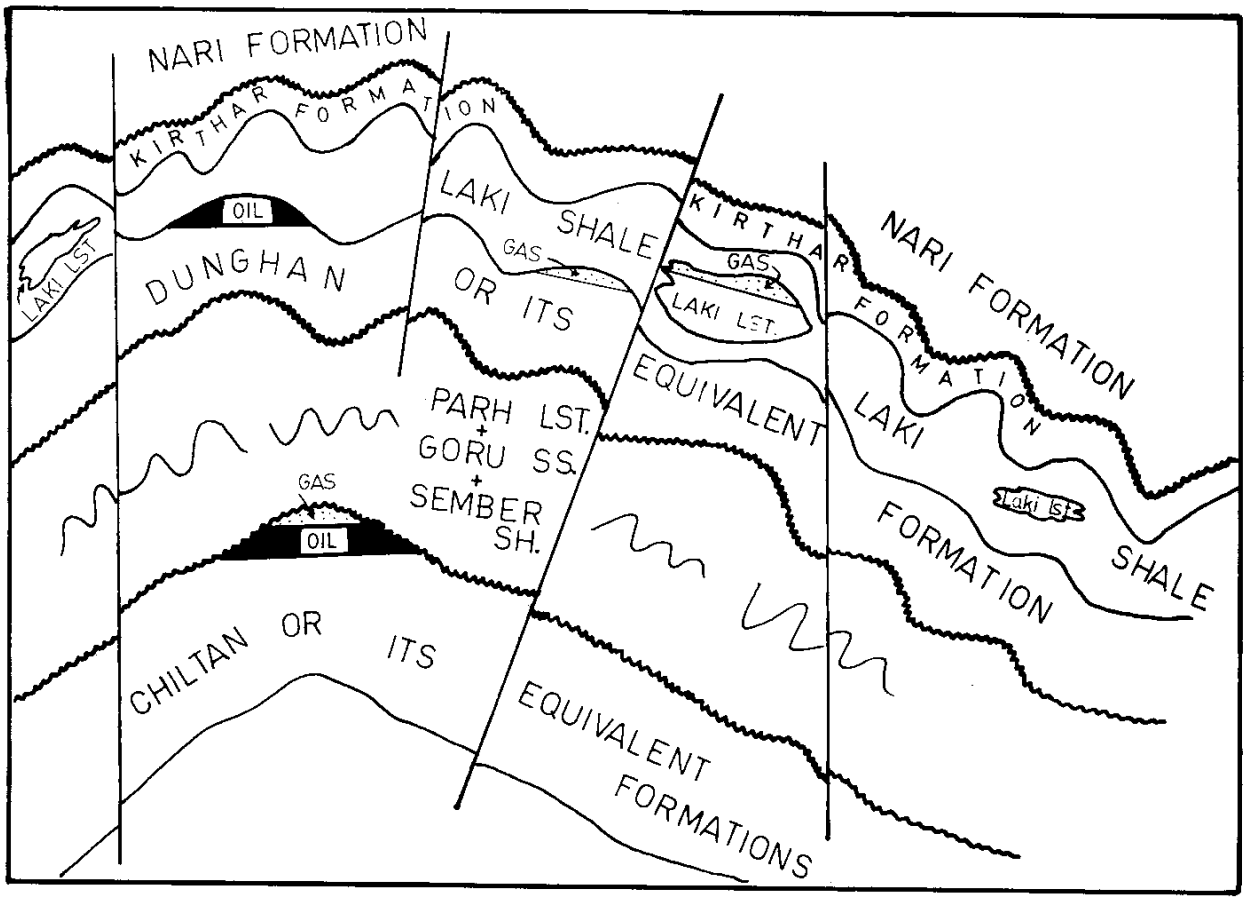

Figure 3— Himalayan (Orogenic) structural configuration in Sulaiman region.

the Himalayan orogeny took place in the region. The orogenic folding was generally in the later part of the Pliocene (Kazmi and Rana, 1982), much after the start of hydrocarbons migration. Thus the epeirogenic structures which formed long before the Himalayan orogeny received most of the oil and gas. In such a situation, it is possible that oil may remain trapped even now in those closures which vertically coincide with and lie in the epeirogenic highs.

The hydrocarbons especially the gas which is still migrating could fill the new traps formed by the folds produced by the Himalayan orogeny. The oil, being much more easily flushable than the gas, might have been fully flushed or displaced by the water under strong hydrodynamic force to which the area at present seems to be subjected.

For a scientific exploration it is, therefore, necessary to work out as much as possible, the configuration of reservoirs before the Himalayan Orogeny, the modification resulting in the shape of the individual closures by this orogeny and the present shape of the regional structure.

The hydrodynamic situation of the prospects should also be studied as much as possible before locating a site for an exploratory well. It seems that the same has not been done during the exploration in the area so far.

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