RESEARCH PROPOSAL

INTEGRATED FORMATION EVALUATION OF THE LUMSHIWAL FORMATION, KOHAT SUB-BASIN AND ADJOINING AREA, PAKISTAN

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Introduction

Kohat Sub-Basin, an integral part of the Upper Indus Basin (between latitudes 32°-34° N and longitudes 70°-74° E), is a distinctive geological entity located in the western Himalayan Fold and Thrust Belt, north-western Pakistan (Abbasi and McElroy, 1991; McDougall and Hussain, 1991; Shah, 2003) (Fig. 1). It is bounded on the north by Main Boundary Thrust (MBT), to the south by Surghar Ranges, and Bannu basin lies to its south-west (Yeats and Lawrence, 1982; Ahmad et al., 1999; Shah, 2003). The Kurram Fault is located on its west, which separates it from Kurram Agency, while river Indus separate it from Potwar Sub-Basin on its east (Khan et al., 1986; Shah, 2003). The exposed stratigraphic succession within Kohat Sub-Basin ranges from Paleogene to recent, while the surrounding areas comprises of exposed rock succession as older as the Jurassic Datta Formation (Meissner et al., 1974; Tapponnier et al., 1981; Treloar and Izatt, 1993; Beck et al., 1996).

The study area covers Tal-block of Kohat Sub-Basin and adjoining area. The first exploratory well in the study area was spudded in 2002 by MOL Pakistan, and since then more than 70 wells have been drilled by various operators, and active exploration is in progress in the area due to high success ratio. In relation to these prolific hydrocarbon discoveries and to fulfill demand of the country, a lot of emphasis on research work has been given on its structure (Shah, 2003; Ghani et al., 2015), petroleum system (Ahmad and Khan, 2012) and sedimentology (Pivnik and Wells, 1996). The Lumshiwal Formation which is the subject of this study was studied in the Samana Ranges for its

environment representing shallow marine setting (Arif et al., 2009). The petrophysical studies of Lumshiwal Formation of Kahi-01 well at Kohat Sub-Basin were done by Saddique et al. (2016) showing the sandstone lithology and average effective porosity upto 0.022.

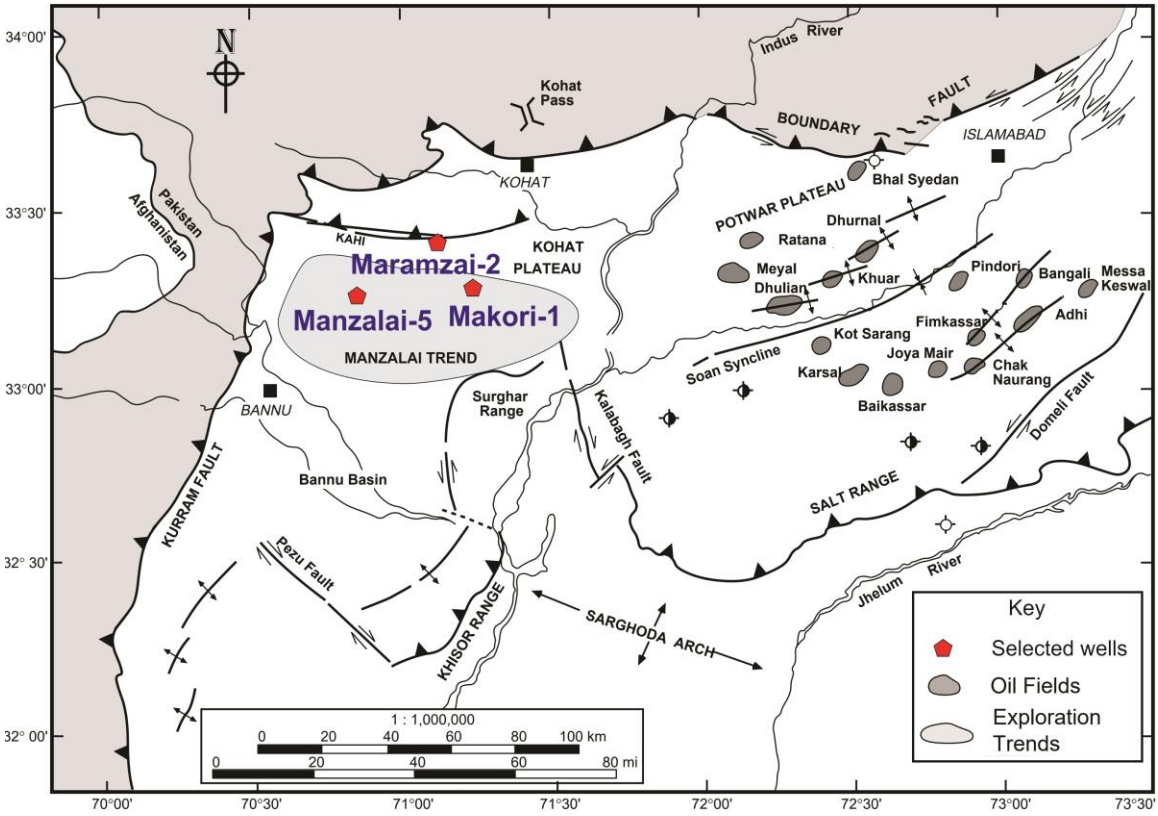

Fig.1. Map showing the location of the selected wells in the Kohat Sub-basin (Sercombe et al., 1993).

In the light of the above mentioned facts, it is intended to perform a detailed reservoir characterization of the Cretaceous Lumshiwal Formation, which is predominantly composed of quartzose sandstone with minor shale intercalations (Arif et al., 2009). The current research incorporates the integration of well data from three selected wells with sedimentological and petrographical interpretation performed on outcrop samples or well

cuttings from the Kohat Sub-basin and adjoining area (Fig.1). The sedimentological and petrographical study will focus on formulation of the sediments into a rock by considering the composition, texture, grain size, sorting and diagenetic attributes in order to draw its depositional environment, spatial distribution of clay minerals and diagenesis. Diagenesis is instrumental in finding the evolution of formation of porosity and permeability in the rocks. Hence, it is important in identifying potential reservoir and describing significant reservoir unit. Diagenesis includes dissolution, compaction, cementation, mineral replacement and clay authigenesis, which can amplify or hinder reservoir productivity on account of chemical and physical alterations of rocks (Flügel, 2010; Awais et al., 2019). The presence of clay mineralogy in sandstone formation damage primary production and reservoir stimulation (Almon and Davies, 1981; Hurst and Archer, 1986). Clay mineralogy and distribution affect the conduction and porosity in a reservoir, therefore, they are studied through petrographical investigation and log analysis for better estimation of reservoir potential of a rock (Awais et al., 2019). Well logs do not provide ample information about clay mineralogy; for that reason, they must be coupled with physical rock characteristics such as outcrop samples or well cuttings.

Aim and objectives

This research aims at formation evaluation of the Lumshiwal Formation in the Kohat Sub-Basin and surrounding area through combine use of well log and petrographical datasets. This aim will be accomplished through the following objectives:

1. To evaluate reservoir quality through an integrated approach of petrophysical and petrographical analyses.

2. To correlate lateral extension and identify depositional environment of the Lumshiwal Formation in the penetrated wells through well log interpretation.
3. To find the effect of spatial distribution of clay minerals on conduction and porosity.
4. To compare at least two shaly-sands models for water saturation.

Significance of Research Work

The current integration of sedimentological and petrophysical interpretations will equip us to precisely characterize the reservoir of cretaceous Lumshiwal Formation in the Kohat sub-basin and surrounding area. The proposed research has pivotal significance in academia and energy industry. The proposed integrated petrographical and petrophysical analysis of the Lumshiwal Formation will improve the understanding of reservoir characterization and thus attain attention of international and local petroleum companies. As an integrated approach, it will inspire researchers and energy industry professionals to create new ideas and techniques for enhancing reservoir quality and production. This integrated reservoir study will link up different professions (geology, petrophysics, geophysics and reservoir geology) to precisely evaluate the reservoir quality

Plan of Research Work

This proposed research work will be carried out under the following plan:

Research activity	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Review of literature				
Data collection				
Data analysis and interpretation				
Thesis writing and submission				

Methodology

Well log interpretation is a sophisticated and prompt method to evaluate reservoir quality. Through well log interpretation, significant petrophysical parameters, e.g., water and hydrocarbon saturation, total and effective porosities and resistivity of water, resistivity of rock values, will be attained. This integration between the actual rock properties with the wireline log interpretation will help to reduce uncertainty in the estimation of petrophysical properties. The sedimentological data will be collected from the outcrop section or well cuttings for petrographical analysis. The log data will be collected from the Directorate General of Petroleum Concession (DGPC).

The methodology will proceed in the following steps:

1. Well log data of the selected wells i.e., Manzalai-5, Makori-1 and Maramzai-2 will be collected.
2. In case of no or insufficient ditch cutting data, field work will be carried out for logging and sample collection from the Lumshiwal Formation in the Kohat sub-basin.
3. Blue-dyed thin sections will be prepared for petrographical, Scanning Electron Microscope (SEM) and X-Ray Diffraction (XRD) analyses.
4. The petrophysical analysis of the Lumshiwal Formation will be performed through well log data, which include deep resistivity (Rt), medium resistivity (MSFL), shallow resistivity (RS), bulk density (RHOB), gamma ray (GR), neutron porosity (NPHI), sonic (DT), spontaneous potential and caliper (CAL). The analysis will be performed using Interactive Petrophysics (IP) software (Saddique et al., 2016).
5. Water saturation computation will be done with the help of two shaly-sand equations for comparison purpose (Shah et al., 2020).

6. A stratigraphic cross section will be created with IP software to recognize lithological units in vertical and horizontal directions with the help of formation tops and well log data.

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