New procedure for evaluation of cap rock across the oil fields in sedimentary basin in SW Iran

Saeid Pourmorad[1] , Dr.Reza Mosavi harami[2], Ahmad Batvandi[3]

Organization of Industries and Mines of khozestan
Ferdowsi University of Mashhad
Islamic Azad university of masjed soliman

Abstract

Due to samples crushing during drilling program, correlation and subdivision of cap rock in a sedimentary basin, to understand for location of casing points, are difficult. The Gachsaran Formation is a cap rock for the Asmari reservoir in Zagros petroliferous basin of SW Iran and is mainly composed of evaporite (anhydrite, gypsum), marl and mostly gypsiferous shale. Six key beds have been identified in the lowermost part of this interval in the cap rock including A, B, C, D, E and F. Two different anhydrite units are present at the upper part and one in the cap rock unit as stated is in the lowermost parts of this formation. In addition to sedimentologic (thin sections of cutting), stratigraphic and petrophysical studies, a semi quantitative analysis has been carried out by SEM-EDS to differentiate the anhydrites and introduce the new key beds. Based on our study, the upper anhydrite unit contains a large amount of Na, Cl, Ba and Ti, while the lower anhydrite unit in the cap rock contains K and Ti with no Cl and Na. Therefore, these two units can be differentiated from each other and 4 new key beds have been introduced. The lithologies of all these key beds are mainly anhydrite and the main elements for identifications are K, Ti, Na and Cl.

Key beds: *cap rock, Gachsaran Formation, elements, SEM-EDS*

Introduction

The most important sedimentological and structural characteristics of cap rocks are the grains size, capillary properties and diffusion of hydrocarbon, lithology, ductility, thickness and lateral continuity. A few techniques are being used to evaluate the cap rocks in oil fields and are mostly based upon petrophysical data [, e.g., Slinger, 1949; Murris et al., 1980; Ameen, 1992; Benison et al., 2000; Bhattacharyya et al., 2000; Einsele, 2000; Bordenave, 2002; Alsharhan et al, 2003; Bahroudi et al., 2003; Kasprzyk, 2003; El-Tabakh, 2004; Allen et al., 2005; Brandano, 2005; Khalifa, 2005; Machel, 2004; Neumann et al., 2005;). In this article, we used elemental analysis to evaluate the sediments of the cap rock in Gachsaran oil field; therefore a new procedure is established. The tectonic events, diagenetic processes and heterogeneity in lithology caused variations in cap rock architecture, therefore it is very important to identify the cap rock and reduce the risk on drilling. Several studies from different basins and reservoirs of different ages showed that the above status is a common occurrence (, e.g., Dunning ton, 1968; Berberian, 1995; Lugli, 2001; Bordenave, 2005; Dill et al., 2005; John et al., 2006). In this study, an oil field with naturally fractured carbonate reservoir, which has a similar characterization all over the basin in southwestern Iran, such as Dezful Embayment, is investigated to employ the best method for subdivision and correlation of the cap rock. In the Gachsaran oil field, hydrocarbon is trapped in a fractured reservoir of the Asmari Foramtion in Gachsaran Anticline, which is typical of this oil-reach area, with 70 km length and 6-7km width.

Geological setting

The Gachsarn Formation of southwest Iran i.e., Dezful embayment, is divided into 7 members from bottom to up (Alavi, 2004). Member one is plays a significant role as a cap rock for Asmari Formation and equivalent formations in Iran and Iraq. The Gachsaran oil field is situated about 220km southeast of Ahwaz city, and the Member one, which is investigated in this study, is composed of anhydrite, gypsum, marl and gypsiferous shale which is a cap rock for naturally fractured hydrocarbon reservoirs of Asmari and Bangestan. In general, the Gachsaran Formation is naturally composed of bituminous shale, limestone, anhydrite and marl that can be found at different depth.

Quality and data Acquisition

The data gathered for this study, include thin sections as well as sample cutting which could be used for electron microscope, equipped by EDS (Energy Dispersive Electroscopy), studies. In addition, log-inject-log, electrical logs and DST (Drill Stem Test) information have been used.

Result and discussion

A variation in Na, Cl, Ba and Ti with depth was integrated with sedimentological, petrographical and log data to assess lithological and elementical differences in the cap rock of the studied field. About six-hundred samples from the Miocene aged formation have been studied (table.1). It is important to note that the samples should not be contaminated with drilling mud. Because, drilling fluid have significant quantities of soluble elements that always occurred as some invasion of the formation surrounding the well bore and any recovered core. To avoid such contaminations, we tried to use samples with less contamination for this study. Base on variations in elements in various lithologies, especially upper anhydrite, 4 key beds have been identified in the cap rock as follows:

Key bed No.1:

This key bed is composed of anhydrite and is located between two main pervious key beds characterized by well-log tools. It is almost below C key bed and bituminous shale. The presence of elements such as K, Na, Cl and Ti can differentiate this key bed from the anhydrite unit in the upper part (Fig.13 and 14). Therefore, it is a good indicator for identification of this key bed.

Key bed No.2:

This key bed is located between two limestone beds. As stated, the key bed is within the marl that can be found between the two limestone beds. The most important attribute of this key bed is the presence of K and salt (corresponding to previous key bed). Variation in elements with depth are measured and reported in table.1.

Key bed No.3:

This key bed is overlain by the previous D key bed which the latter key bed was logged and characterized by petrophysical tools. It is rarely observed a marly layer between anhydritic unit and upper limestone. It could be concluded that this key bed clarified by the lack of sodium, chloride and also presence of potassium.

Key bed No.4:

This Key bed is commonly thin. It is overlain the Asmari Formation, and then overlain by the previous F key bed. The former key bed itself does not as importance as other key beds, because, it is located at the bottom of casing point. The key bed No.4 can be distinguished by presence of potassium and lack of sodium and chloride in addition to common elements which are presented in key beds and upper anhydrites.

Petrgraphical textures and heterogeneity in lithology:

Petrographical and sedimentary textures and heterogeneity in various lithologies are indicators for distinguishing key beds during development phases in different directions and scales. Based on petrographical studies which are accomplished on 600 thin sections, it is clarified that cap rock (Member 1 of the Gachsaran Formation) is mostly composed of evaporitic rocks (mainly anhydrite along with some gypsum). In addition, some non-evaporitic sediment such as bituminous shale, marl and carbonate rocks is present. The most important textures, which observed into anhydritic deposits, are chevron, nodular, microcrystalline, laminate, spherolitic, current, needle and block in a sulfate and mudstone matrix.

Conclusions and recommendations:

- Using variations in ubiquitous elements in cap rock, it can be divided into several key beds.
- Base on variation in elements, this study show that anhydrite in a sedimentary basin and even another layers can be a cap rock.
- The identified cap rock contains low evaporitic elements such as Na, K and Ti with respect to upper units.
- Change in thickness always isn't associated with variation in depth. On the other hand, during drilling and development program shouldn't forecast the thickness with dip, in order to determining of top of the reservoir formation.

Referenc

1-Alavi, M., 2004, Regional stratigraphy of the Zagros Fold-Thrust belt of Iran and its proforeland evolution, American Journal of Science, Vol.304, P. 1-20

2-Allen, P. A. and Allen , J . R.2005 , Basin analysis principles aand applications, BlackWell Scientific Publications, P.451

3-Alsharhan, A.S., and Kendall, C.G.St.C., 2003, Holocene coastal carbonates and evaporates of the southern Arabian Gulf and their ancientan alogues, Earth Science Reviews, v. 61, p. 191–243

4-Ameen, M.S., 1992, Effect of basement tectonics on hydrocarbon generation, migration and accumulation in northern Iraq, American Association of Petroleum Geologists Bulletin, v. 76, p. 356–370.

5-Bahroudi, A., 2003, The effect of mechanical charecteristics of basal decollement and the basement structures on deformation of the Zagros basin, Uppsala University, Ph.D thesis

6-Benison, K.C., and Goldstein., R.H., 2000, Sedimentology of ancient saline pan: an example from the Permian Opeche Shale, Williston Basin, North Dokota, U.S.A., Journal of Sedimentary Research, v. 70., no. 1, p. 159-169

7-Berberian, M., 1995, Master "blind" thrust faults hidden under the Zagros folds: active basement tectonics and surface morphotectonics. Tectonophysics 241,p.193-224.

8-Bhattacharyya, A., and Chakraborty, C., 2000, Analysis of Sedimentary Successions, Balkema Publishers, 408p

9-Bordenave, M.L., 2002 , The Middle Cretaceous to Early Miocene Petroleum System in the Zagros Domain of Iran, and its prospect Evaluation ,AAPG Annual Meeting , March 10-13 ,2002 ,Houston Texas.

10-Bordenave, M.L., and Hegre, J.A., 2005, The influence of tectonics on the entrapment of oil in the Dezful Embayment, Zagros Foldbelt, Iran, Journal of Petroleum Geology, Vol.28 (4), pp.339-368.

11-Brandono, M., Corda, L.,and Maritti, G., 2005, Orbital forcing recorded in subtidal cycles from Lower Miocene siliciclastic-carbonate ramp (Central Italy), Terra Nova Oxford, v.17, no.5, p.434

12-Dill, H.G., Berner, Z., Stuben, D., Nasir,S., and Al-Saad, H., 2005, Sedimentary, facies, mineralogy, and geoche mistry of the sulphate bearing Miocene Dam Formationin Qatar, Sedimentary Geology, v. 174, p. 63–96

13- Dunham, R .J ., 1962, Classification of carbonate rocks according to depositional texture, in Ham, W. E .,ed .,Classification of Carbonate Rocks: American association of Petroleum Geologists Mem.1, P. 108-121

14-Einsele, G., 2000, Sedimentary Basine, Evolution, Facies, and Sediment Budget, Springer-Verlag Berline Heidelberg, 792 p.

15-El-Tabakh, M., Mory, A., Schreiber, B. C. and Yasin, R ., 2004, Anhydrite cements after dolomitization of shallow marine Silurian carbonates of the Gascoyne Platform, Southern Carnavon Basin, Western Australia, Sedimentary Geology, v.164,pp. 75-87.

16-John, C.M., Adatc, T., and Mutti, M., 2006, Regional trends in clay mineral fluxes to the Queensland margin tic to middle Miocene global colling, Palaeogeography, Palaeoclimatology, Palaeoecology, v. 233, p. 204-224

17-Kasprzyk, A., 2003, Sedimentological and diagentic patterns of anhydrite deposits in the Badenian evaporate basin of the Carpathian Foredeep, southern Poland.sediment. Geol., v.158, P. 167-194

18-Khalifa, M.A., 2005, Lithofacies, diagenesis and cyclicity in Lower Member of the Khuff Formation (Late Permian), Al Qasim Province, Saudi Arabia, Journal of Asian Earth Scienes, v. 78, p. 100-123.

19-Lugli, S., 2001 , Timing of post-depositional events in the Burano Formation of the Secchia valley (Upper Triassic, Northern Apennines), clues from gypsum-anhydrite transitions and carbonate metassomatism. Sediment. Geol.,v. 140,p.107-122

20-Machel, H.G., 2004, Concepts and models of dolomitization:a critical reappraisal, In: Braithwaite, C.J.R., Rizzi, G., and Darke, G., (eds) The Geometry and Petrogenesis of Dolomite Hydrocarbon Reservoirs, Geological Society, London. Special Publications, 235, p.7

21-Murris, R. J., 1980, middle East, stratigraphic evolution and oil habitat. American Association of Petroleum Geologist Bulletin, 64,P. 598-617

22-Neumann, N . T., Rausch, T., Leipe, O., Dellwig, Z., Berner and Botteher, M., E., 2005, Intense pyrite formation under low-sulfate conditions in the Achterwasser lagoon, SW Baltic Sea: Geochimica et Cosmochimica Acta, v. 69, no. 14, p.3619–3630

23-Slinger, F.C.P.,1949, The Agha jari Cap Rock , Report No. -751.