

Mössbauer Spectroscopic Study of the Sedimentary Samples Collected from Barmer Hill Formation of Northern Barmer Basin, Western Rajasthan (India)

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ABSTRACT: The Barmer Hill Formation is a Paleocene lacustrine deposit occurring in the Barmer Basin of northwestern India. The lake developed entirely within the rift basin and its sediments comprise a complex of shallow to deep water deposits. The Barmer Hill Formation transitionally overlies the Fatehgarh Formation and contains the thickest and best-developed lacustrine shales. Barmer Hill isopach changes show rapid thickening on downthrown faults, indicating a strongly synrift depositional history that subsequently controlled reservoir distribution. The Barmer Hill Formation contains a wide variety of facies, and basal, wide spread black shale, informally referred to as the 'Barmer Hill MFS (Maximum Flooding Surface). In the present Mössbauer spectroscopic study of the sedimentary samples collected from Barmer Hill Formation was carried out. The complex pattern of Mössbauer parameters attributed goethite; pyrite and hematite minerals were recorded.

I. INTRODUCTION

The Barmer Basin is the northward extension of the better known hydrocarbon producing Cambay Basin (Compton, 2009). Extensional fault growth occurred mainly during the Paleocene-Eocene times. low permeability "tight" formations and a similar approach was taken for the Barmer Hill Formation. Basin sediments are recognized as pre-rift, syn-rift and post-rift. The pre-rift stratigraphy consists of Mesozoic and older rocks. Barmer Hill Formation was deposited directly over the Fatehgarh Formation and underlies the Dharvi Dungar Formation, which is the regional seal to both of these formations. The Barmer Hill siliceous reservoir is composed of microcrystalline quartz. The upper part of Barmer Hill Formation comprises a range of lithofacies that consist of siltstone, silty clay stone, clayey siltstone alongwith subordinate sandy siltstone, all of which are siliceous and variably laminated. As these rock types are diagenetically altered and generally have an indurated, fine grained appearance the textural term "porcellanite" (Boggs, 2009) has been adopted for their general description. Barmer Hill reservoir is highly suited to hydraulic fracturing and as these are enclosed by ductile shales this will prevent the hydraulic fractures to extend beyond the porcellanite reservoir.

Geology Stratigraphy: The Barmer basin consists of a thick Jurassic to Eocene accumulation of shallow marine to fluvial sedimentary sequences. The Late Proterozoic Malani igneous suite/ rhyolites (MIS) constitute its basement, which is exposed around the western rift shoulder of the Barmer basin. The Fatehgarh and Barmer Hill Formations are the major hydrocarbon reservoirs of the Barmer basin.

The Mangala and Aishwarya/Aishwariya oil fields have been producing hydrocarbons from the Barmer Hill Formation (Shiju et al. 2008; Lobo et al. 2015). The available stratigraphic information from literature (Sisodia and Singh 2000; Mathur 2003; Mathur et al. 2005; Sisodia et al. 2005; Compton 2009; Beaumont et al. 2015; Dolson et al. 2015; Kothari et al. 2015).

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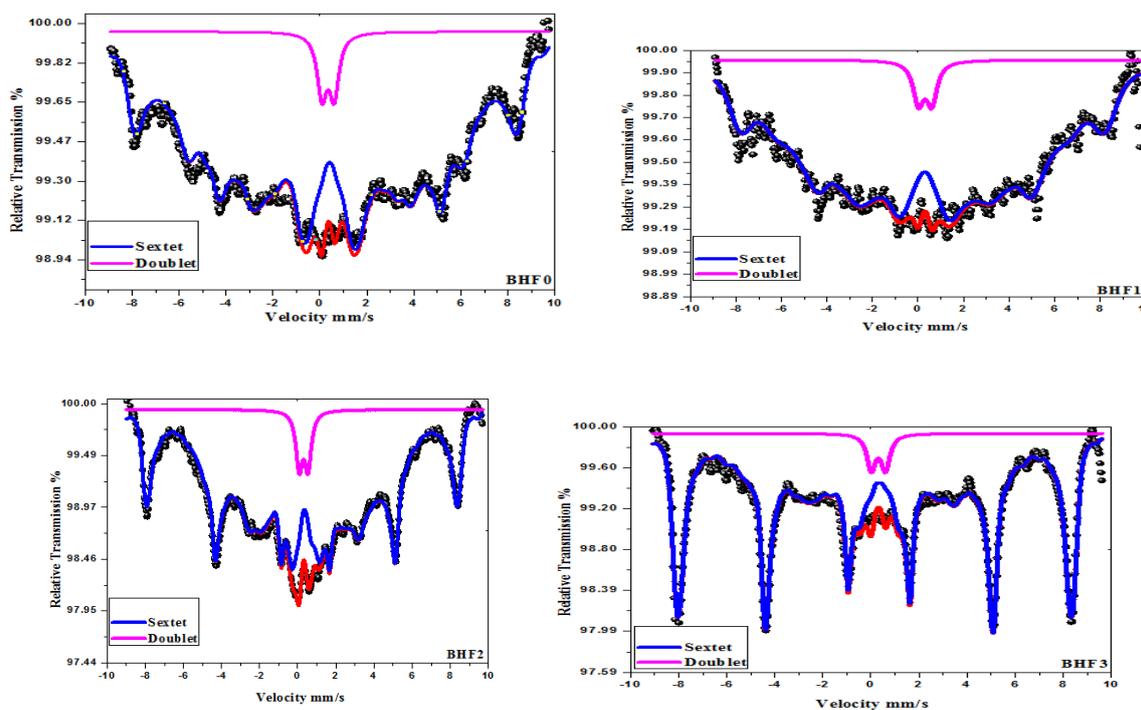
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Mössbauer spectroscopy is a spectroscopic technique based on the Mössbauer effect. This effect, discovered by Rudolf Mössbauer in 1958, consists of the nearly recoil-free emission and absorption of nuclear gamma rays in solids.⁵⁷Fe Mössbauer spectroscopy is particularly useful for the characterization of iron-bearing minerals because it gives first-hand information about the atomic environment of iron nuclei and, hence, leads to direct identification of the compounds and their chemical states Experimental

For present study six sedimentary samples were collected from Barmer Hill Formation (BHF-01 to BHF-05). In the present investigation, about 25gm of each sample (BHF-00 to BHF-05) were first ground to fine powder. Fraction of these powdered samples was used for Mössbauer study. The Mössbauer absorbers were prepared by using fraction of these finely ground powder sediment in a sample holder (25 mm in diameter). The thickness of the absorbers was always kept constant. Mössbauer spectra were recorded at room temperature (300K) with a conventional constant acceleration spectrometer using a 10 mCi source ⁵⁷Co in an Rh matrix. The isomer shift (IS) has been reported with respect to the centroid of a 25- μ m- thick α -iron foil spectrum. Each spectrum was fitted using a computer program. This program assumes the spectrum to be the sum of Lorentzians. In most of the cases, width and intensity of the two halves of a quadrupole doublet or six halves in case of sextet were constrained to be equal. While in the case of sextet intensity of line 1 and 6, 2 and 5 and 3 and 4 were constrained to be equal. The relative intensities of various mineral components or sites were calculated by adding the areas of the two halves of the corresponding doublet or six halves of the corresponding sextet and are expressed as a fraction of the total area of resonant absorption. Solid lines in the spectra reported here represent computer-fitted curves and dots represent the experimental points. The X² values are generally obtained in this range. However, a little deviation in the X² has been accepted on few occasions when the iterations do not yield to further improvements in X². Such a situation arises when weak lines are present. Powdered XRD pattern for these samples have also been collected.

Typical Mössbauer Spectra's at room temperature:



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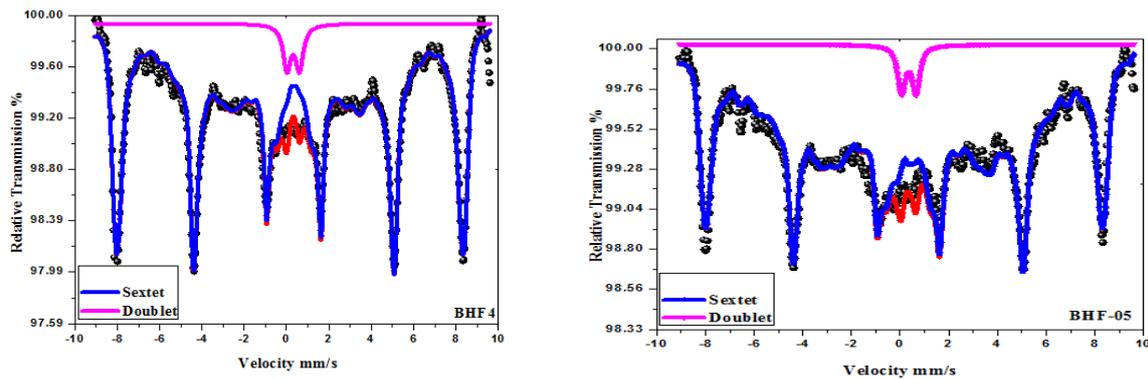


Figure-01 Mössbauer spectra's of the samples obtained from Barmer Hill Formation

Table-01: Mössbauer parameters of Barmer Hill Formation

Samples code	Sub Spectrum	Line width (LW) (mm/s)	Isomer Shift (IS) (mm/s)	Quadrupole Splitting (QS) (mm/s)	Hyperfine Magnetic Field	Relative Area %	χ^2
BHF0	S1	0.43	0.32	-0.14	32.56	96.36	1.453
	D1	0.49	0.34	0.51	-----	3.64	
BHF1	S1	0.58	0.25	-0.08	32.28	96.70	1.008
	D1	0.55	0.31	0.58	-----	3.30	
BHF2	S1	0.26	0.31	-0.17	29.23	95.60	1.179
	D1	0.41	0.30	0.45	-----	4.40	
BHF3	S1	0.26	0.25	-0.18	37.08	96.43	1.632
	D1	0.43	0.31	0.58	-----	3.57	
BHF4	S1	0.26	0.25	-0.18	37.08	96.63	1.007
	D1	0.42	0.32	0.59	-----	3.37	
BHF5	S1	0.30	0.25	-0.17	34.47	97.22	1.245
	D1	0.38	0.35	0.58	-----	2.87	

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II. RESULTS & DISCUSSION

Mössbauer spectra of samples BHF-0 to BHF-05 are displayed in Fig.1.. The Mössbauer parameters are given in Table 1 for samples BHF-0 to BHF-05. It can be seen from Fig.1 and Table 1 that Mössbauer spectra of these samples (BHF-0 to BHF-05) exhibit presence of sextet and one quadrupole doublet. Sextet has been shown by S_1 and quadrupole doublet by D_1 . These sextets show anomalous (very low) magnetic hyperfine field (MHF). To the best of our knowledge presence of such sextet with so much low MHF value in sedimentary samples was not reported in literature, but magnetic hyperfine field range nearby goethite. These sextets may be attributed to very small (ultra-fine) oxide particles. Such ultrafine oxide particles are usually not expected to form in usual weathering processes. Quadrupole doublet Mössbauer parameters show presence of pyrite in the all samples.

REFERENCES

1. Mørup Steen, Franck Jørgen et. al., Mössbauer spectroscopy study of the chemical state of iron in Danish Mesozoic sediments, FUEL, V. 64, 1985.
2. Hoffman E., Seifu, D. et. al. , Axtell and Allende: A Mössbauer spectroscopy study , Meteoritic and planetary Science 35,431-434(2000).
3. Wagner F.E., Wagner U. Mössbauer Spectra of Clays and Ceramics. Hyperfine Interactions, v.154, pp.35-82(2004).
4. Mathur, S.C., Gaur, S.D., Loyal, R.S., Tripathi,A., and Sisodiya, M.S. Spherules in the Fatehgarh Formation(Cretaceous) of Barmer Basin, India. Gondwana Res.,V. 8,pp.579-584(2005a).
5. Mathur, S.C., Mathur, S.K. and Loyal, R.S. First Report of microvertebrate assemblage from Cretaceous Fatehgarh Formation. Jour. Geol. Soc. India, v.67, pp.759–769(2006).
6. Compton Paul. M. The Geology of the Barmer Basin, Rajasthan, India and the origins of its major oil Reservoir, The Fatehgarh Formation, Petroleum Geoscience,V.15, pp.117-130, (2009).
7. Chandra, U., Sharma, P., Parthasarathy, G. and Sreedhar, B. ^{57}Fe Mossbauer spectroscopy and electrical resistivity studies on naturally occurring native iron under high pressures up to 9.1 GPa. American Mineralogist, v.95, pp. 870-875(2010).
8. E. V. Meerwall, “A least-square spectral curve fitting routine for strongly overlapping Lorentzians or Gaussians”, Computer physics communications, Vol. 9, pp. 117-128, 1975
9. Dalson, J.D., Burley, S.D. and Sunder, V.R. The Discovery of the Barmer Basin Rajasthan, India and its petrology, AAPG Bull., V.99,pp.433-46(2015).
10. Tripathi, S. K. M., M. Kumar, and D. Srivastava, 2009, 1467 Palynology of Lower Paleogene (Thanetian-Ypresian) 1468 coastal deposits from the Barmer Basin (Akli Formation), 1469 Western Rajasthan, India: Palaeoenvironmental and palaeo- 1470 climatic implications: Geologica Acta.
11. Whiteley, N. J., S. Burley, B. Ananthakrishnan, and D. Ginger, 1487 2012, The discoveries of the Barmer Basin, Rajasthan, 1488 India (abs.): AAPG International Conference and 1489 Exhibition, Singapore, AAPG Search and Discovery 1490 Article #90155.
12. Morley, C. K., C. Haranya, W. Pongwapee, A. Komsawan, and 1315 N. Wonganan, 2004, Activation of rift oblique and rift paral- 1316 lel pre-existing fabrics during extension and their effect on 1317 deformation style: Examples from the rifts of Thailand: 1318 Journal of Structural Geology, v. 26, p. 1803–1829.
13. Boggs, S. Jr: Principles of Sedimentology & Stratigraphy, Merrill Publishig Company, 1995. Britt, L. K. and Schoeffler, J.: “The Geomechanics of a Shale Play: What Makes a Shale Prospective!”, paper SPE 125525 presented at the 2009 SPE Eastern Regional Meeting, Charleston, West Virginia, USA, September 23-25.
14. Sisodia, M.S., Singh, U.K., Lashkari, G, Shukla, P N, Shukla, A.D. and Bhandari, N: Mineralogy and trace element chemistry of the Siliceous Earth of Barmer basin, Rajasthan: Evidence for a volcanic origin. J. Earth Syst. Sci. 114, No. 2, April 2005, p. 111-124.
15. Bladon, A. J.; Clarke, S. M.; and Burley, S. D. 2015. Complex rift geometries resulting from inheritance of pre-existing structures: insights and regional implications from the Barmer Basin rift. J. Struct. Geol. 71: 136–154.



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16. Roy, A. B., and Jakhar, S. R. 2002. Geology of Rajasthan (northwest India): Precambrian to recent. Jodhpur, Scientific, 421 p.
17. Sisodia, M. S., and Singh, U. K. 2000. Depositional environment and hydrocarbon prospects of the Barmer Basin, Rajasthan, India. *Nafta (Zagreb)* 51:309–326.
18. Tripathi R. P. et. al., ⁵⁷Fe Mössbauer Spectroscopy study of organic rich sediments (source rocks) from test well CT-1, Chinnewala structure of Jaisalmer basin, India, *Geoscience Frontiers* (2015).