



The role of fracturing and mineralogical alteration of basement gneiss in the oil exhsudation in the Sousa Basin (Lower Cretaceous), Northeastern Brazil



Ismar de Souza Carvalho*, Julio Cezar Mendes, Thiago Costa

Universidade Federal do Rio de Janeiro, Departamento de Geologia, Instituto de Geociências, Av. Athos da Silveira Ramos, 274, Cidade Universitária, Ilha do Fundão, 21.910-200 Rio de Janeiro, RJ, Brazil

ARTICLE INFO

Article history:

Received 22 January 2013

Accepted 5 June 2013

Keywords:

Oil exhsudation

Basement rocks

Sousa Basin

Borborema Province

ABSTRACT

This work focuses the geological context of an oil sample obtained from an exhsudation in a superficial well, located at Salguinho Farm, Sousa Basin, at the central Borborema Province, Brazil. It is a light oil, with 81.1% of saturated compounds and a predominance of C17 and C23 n-paraffins, in which biomarkers point out to a non-biodegraded mature oil. Although the source rocks of this oil are unknown, the reservoir are metamorphic rocks from the basement, in a structural arch nearside the depocenter area of the basin. This lithology corresponds to ortho-derived gneiss strongly modified by ductile and brittle deformation (fracturing), as well as mineralogical alteration due to retrometamorphic and hydrothermal reactions. Here we emphasize and discuss the importance of such modifications underwent by the gneiss in the development of a propitious porosity and permeability for the further oil accumulation.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

The Sousa Basin is part of a sedimentary basin system, known as the intracontinental basins of Northeast Brazil (Ponte, 1992). These basins are mainly sites of Cretaceous sedimentation, whose origin and evolution were controlled by the reactivation of pre-existing tectonic structures in the basement (Precambrian rocks) during the Jurassic and Cretaceous. This reactivation was closely related to the opening of the South Atlantic Ocean and normal and trans-current faults were the main structural style for the opening of grabens and half grabens in the central region of Northeast Brazil during the Early Cretaceous. They show an SW–NE orientation determined by the structures of competent supracrustal rocks within the Borborema Province. This lowlying trend has been called the Araripe-Potiguar depression (Mabesoone, 1994; Valença et al., 2003). The Sousa Basin is a half graben, and together with the neighboring Vertentes, Uiraúna-Brejo das Freiras and Pombal basins, are known as the Rio do Peixe Basins.

They were originated as a consequence of the tectonic movements which resulted in the separation of South America and Africa (Mabesoone, 1994; Valença et al., 2003). The region was periodically affected by the formation of intracontinental rifts, for the last

time from Callovian onwards (Matos, 1992). As a consequence, several sedimentary basins resulted from the differential reactivated fault movements within the ancient Precambrian belt zone (Fig. 1). The crustal extension gave rise to the generation, along the preexisting Precambrian fault lines, of SW–NE oriented, tilted half-grabens (Ponte, 1992; Valença et al., 2003).

In Rio do Peixe Basins, the combination of the current level of erosion with the geometry of major faults and bedding dips shows the existence of different half-grabens (Vertentes, Uiraúna-Brejo das Freiras, Sousa and Pombal). The structural and geophysical data presented by Córdoba et al. (2008) indicate that the sediment column may be more than 2 km thick in the deep portion of depocenters, or even attain 2.5–3 km thick in the case of Brejo das Freiras half-graben. Segments of Brasiliano-Pan-African EW-trending (Patos lineament) or NE (Portalegre lineament) shear zones, acted as brittle shear zones during the Early Cretaceous reactivation. The combination of slickenlines and kinematic indicators helped to establish the displacements along the faults, normal in NE structures, such as the Brejo das Freiras fault (which defines the faulted border of the homonym half-graben) and oblique, normal-sinistral, in the EW trending São Gonçalo; this fault defines the faulted border of a transtractive block, in the case of Sousa half-graben (Córdoba et al., 2008). In each half-graben, the layers are tilted to the faulted borders, in whose vicinity may occur syntectonic conglomerates. Both border faults are structured in steps, which usually represent relay ramps.

* Corresponding author. Tel.: +55 21 2598 9405.

E-mail address: ismar@geologia.ufrj.br (I.deS. Carvalho).

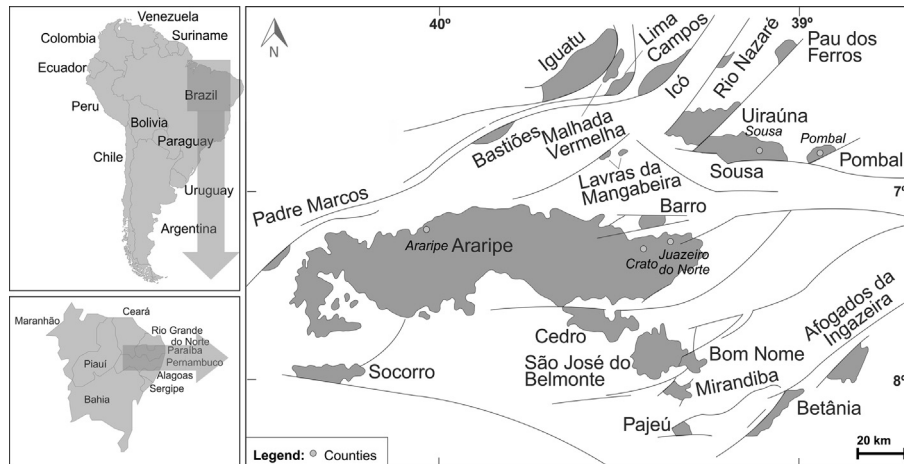


Fig. 1. Location area of the Sousa Basin and the distribution of the intracratonic basins of NE Brazil (modified from Fortier and Schultz, 2009).

Based on the structural style and petrographic-diagenetic features, Córdoba et al. (2008) inferred larger original dimensions for this basin and similar counterparts in the region, which were reduced (with exposure of the crystalline highs) by the significant erosion that occurred in late to post-rift and subsequent evolutionary stages. Two alternative hypotheses try to explain the evolution of these rift basins, either by a model considering NW extension during Neocomian-Barremian times, or by a model involving reactivation of EW and NE strike-slip Precambrian lineaments, but also involving NW extension.

Considering the existence of oil accumulated in gneissic rocks as a reservoir, this work aims an overview of the Sousa Basin stratigraphy, paleoenvironmental and architecture, as-well-as a broad description of its basement gneiss. The study of this rock was provided using a 3.01 m of a core obtained from a drilling – 2-SS-PB (core diameter 1.5") which reached the metamorphic rock in a structural dome of the basement after 28 m from surface. The drill location is the Sítio Salguinho (Salguinho Farm) at 6° 43'25,7"S and 38° 20'17,1"W, Sousa County, Paraíba State.

The investigation on the basement rocks of the basin is relevant because the fractures system found in those rocks probably act as a natural way to the oil flux and, at least, resulting in loss of part of this oil. Taking into account the occurrence of oil and gas in igneous and metamorphic rocks, this article also presents a brief description of some important oil fields from around the world located in basement rocks.

2. The Borborema Province: a summary

The Borborema Province (Almeida et al., 1981) is characterized by zones of supracrustal rocks embedded among ortho-derived gneissic-migmatitic terrains. Paleoproterozoic and rare Archaean blocks of the gneissic basement are covered by Meso- to Neoproterozoic metasedimentary rocks. Hence it consists of a complex mosaic constituted by fold systems and crustal segments separated by an expressive set of shear zones (Brito Neves et al., 2000). The rocks present diverse structural trends that are grouped into fold systems, resulting in the superposition of diverse tectonic, metamorphic and magmatic events upon the sedimentary and volcanic rocks accumulated since the Mesoproterozoic (Almeida and Hasui, 1984). A Neoproterozoic age has been obtained for the majority of these fold systems. Granitoid rocks of Brasiliano age crosscut almost all the units of the province. The Brasiliano orogeny has been considered the main event which controlled the structural and low to- high grade metamorphic style of the province, although

the Transamazonian orogeny was the main crust forming event of the region (Van Schmus et al., 1995).

According to Trompette et al. (1993) the Borborema Province belonged to a larger Precambrian paleocontinent extending into Africa, formed by convergence and collision of the São Luís/West African and São Francisco/Congo-Kasai cratons. This Precambrian basement was characterized by thermal and tectonic-magmatic processes which took place during the Meso- and Neoproterozoic continuing into the Cambrian-Ordovician (Matos, 1992).

The Borborema Province is characterized by large shear zones of predominantly NE-SW and E-W trend, which divide the province in three distinct segments, North, Central and South Domain (Van Schmus et al., 1995). The study area of this work is located at the North Domain. Two important crustal scale lineaments, Patos and Pernambuco (Ebert, 1970) cut the Borborema Province from east to west and the former is the southern border of the Rio do Peixe Basins (Fig. 1).

2.1. The Precambrian geology around Sousa Basin

The Sousa Basin is inserted in the Borborema Province, which partially corresponds to Neoproterozoic Brasiliano/Pan-African belts. The complex network of NE-SW and E-W-trending shear zones is one of the outstanding structural features of this province, which show brittle reactivation associated with Gondwana breakup in the Early Cretaceous (Castro et al., 2007; Françolin and Cobbold, 1994).

The Precambrian geological framework of the region adjacent to the Sousa Basin was described by Medeiros (2008). Archean to Paleoproterozoic basement rocks covered by Paleoproterozoic to Neoproterozoic metavolcanic and metasedimentary units delineate three large crustal domains, which are denominated as Jaguaribeano, Rio Piranhas-Seridó and Zona Transversal Domains. A significant number of plutons of Ediacarian age are widespread in the neighborhood of the Rio do Peixe Basins, being concordant and/or crosscutting the structures of the ancient units. Brasiliano age deformation is pervasive in all the lithologies, strongly obliterating older deformation phases (Fig. 2).

The main structural features of the region correspond to the dextral Malta (a branch of the Patos shear zone), Portalegre, Jaguaribe and Orós shear zones, which resulted from Brasiliano age transcurent deformation. The Malta and Portalegre shear zones set bounds for the southern and western Rio do Peixe Basin margins, respectively. Pre- transcurent deformation event is locally characterized as folds and penetrative foliation in the

Download English Version:

<https://daneshyari.com/en/article/6431428>

Download Persian Version:

<https://daneshyari.com/article/6431428>

[Daneshyari.com](https://daneshyari.com)