

Diagenesis and Basin Development (Aapg Studies in Geology)



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The role of depositional setting and diagenesis on the reservoir quality of Devonian sandstones from the Solimões Basin, Brazilian Amazonia

Rodrigo Dias Lima¹, Luiz Fernando De Ros^{*}

¹Instituto de Geociências, Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves, 9500, 91501-970 Porto Alegre, RS, Brazil
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Abstract

Devonian sandstones of the Ureí Formation are important oil exploration targets in the Solimões Basin, western Brazilian Amazonia. The basin fill comprises Ordovician to Permian sedimentary successions, Triassic diabase dykes and sills, and Cretaceous to Recent continental deposits. This study deals with the Upper Devonian interval, which consists of sharp-based, progradational sandstones, attributed to a storm-dominated shelf complex formed during an overall transgressive system tract, overlain by Frasnian-Famennian black shales. In spite of their large lateral extent, the exploitation of these sandstones is complicated by intense diagenesis, which strongly affected reservoir quality. The main processes of porosity reduction are mechanical and chemical compaction and cementation by quartz overgrowth, carbonates (siderite and dolomite) and fibrous illite. Porosity (up to 28%) was preserved by the inhibition of quartz overgrowth cementation and pressure dissolution by grain-rimming, eogenetic, microcrystalline quartz and associated chalcedony, or smectite. Early diagenetic silica precipitation is related to the dissolution of sponge spicules, which were concentrated in storm-reworked hybrid arenites and in interbedded spiculate deposits. Locally, massive quartz cementation and recrystallisation occurred as a consequence of hot fluids circulation related to Triassic magmatism.

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1. Introduction

During 70s and 80s, diagenetic studies on clastic reservoirs quality concentrated in the mechanisms of secondary porosity generation (Franks & Forester, 1984; Giles & Marshall, 1986; Schmidt & McDonald, 1979; Surdam, Boese, & Crossey, 1984). On the other hand, last decade research dealt mostly with the diagenetic mechanisms of porosity preservation (Aase, Bjorkum, & Nadeau, 1996; Bloch, Lander, & Bonell, 2002; Jahren & Ramm, 2000; Pittman, Larose, & Heald, 1992). The objective of this study is to unravel the controls on the observed preservation of porosity and variation of quality in the Devonian sandstone reservoirs of the Solimões Basin (western Brazilian Amazonia).

Although the vast Solimões Basin has been explored throughout the past three decades, little is known about the reservoir quality controls of the Devonian sandstones of the Ureí Formation. Most of the exploration efforts were concentrated in the Carboniferous sandstones of the Juruá Formation, which contain the largest gas accumulations of Brazil (close to $200 \times 10^9 \text{ m}^3$ of gas *in place*, and $11 \times 10^9 \text{ m}^3$ of associated oil *in place*). The remote geographic location of the Solimões Basin and the extremely high costs of gas production and transportation in the Amazonian forest has recently increased the interest in the exploration for the Devonian sandstones, because they contain mainly oil, occur throughout most of the basin, and are closely associated to the major basin source rocks, the Jandiatuba shales (Mello, Koutstaal, Mohrlok, & Baccoccoli, 1994). However, exploration of the Ureí sandstones is complicated by the heterogeneous quality of these reservoirs, which range from highly porous (up to 28%) to extremely tight.

^{*} Corresponding author. Fax: +55-51-3316-7047.

E-mail address: lidesos@inf.ufrrgs.br (L.F. De Ros).

¹ National Petroleum Agency Grantee; present address: PETROBRAS Corporate University, Rio de Janeiro, RJ, Brazil.

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