Petrologic Calibration and Correlation of Well Logs in Precambrian (Late Proterozoic) Basement Rocks, Tucumcari Basin, New Mexico

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Petroleum exploration in eastern New Mexico generally targets Paleozoic strata. Rarely do wells in the Tucumcari Basin exceed 10,000 feet in depth or drill significantly into basement rocks. In the mid 1990s two unusually deep wells were drilled in the basin in Guadalupe County, New Mexico, probably on the basis of deep seismic reflections. They were the Labrador Oil Company 1 State Mr. Jones (16,923 feet in depth; drilled 1995) and the 1 Mescalero (14,597 feet in depth; drilled 1996; Figure 1).

The combination of cuttings and a modern log suite from the 1 Mescalero allows detailed characterization of the rocks and calibration of well log curves. There are three major igneous rock types present: granite, quartz syenite (grading downward into diorite) and gabbro. A metasedimentary-metavolcanic sequence is also present, locally metamorphosed (hornfels and marble) by contact with intruding gabbro.

Gabbro is a medium to coarse crystalline rock. Two large intrusions of gabbro occur at depths of 1759-1859 m and 1905-2155 m. A number of small dikes are inferred in the lower part of the well. The gabbro appears to be the youngest rock unit within the basement, since it causes metamorphism in other Proterozoic rock units. Gabbro that intrudes the Debaca sequence yields a biotite $^{40}Ar/^{39}Ar$ age of 1090 ± 4 Ma (Amarante and Kelley, 2001)

The metasedimentary sequence (2155 to 2550 m) consists of two main units, the Upper Debaca and the Lower Debaca (Figure 2). The Upper Debaca is dominated by carbonate-cemented sandstone, tuffaceous sandstone, and marble. The Lower Debaca consists of intercalated rhyolite, sandstone (light-dark green sandstone), dolomite (sandy dolomite and dolomitic sandstone), argillite, and arkose. The age of the Debaca is bracketed to be 1.1 to 1.3 Ga (Amarante and Kelley, 2001).

Quartz syenite (2650 to 31600) is medium to coarse-crystalline, pink-light orange to light gray in color, and is dominated by potassium feldspar. This rock shows a remarkable increase in quartz content with depth passing transitionally from syenite to quartz syenite. Near its basal contact, quartz syenite grades to quartz diorite. Near its top, the syenite is strongly altered and exhibits a well-developed weathering profile indicating a disconformable contact between the quartz syenite and overlying Debaca sequence. Quartz syenite yields a U-Pb zircon age of 1333 ±52 Ma (Amarante and Kelley, 2001).

Granite (3250 to 4100 m) has a porphyritic texture comprising large phenocrysts of plagioclase (1.2-2.0 mm), potassium feldspar and quartz, in a matrix composed mostly by quartz, feldspar and mafic minerals (hornblende and biotite), in decreasing order. Accessory minerals are magnetite, apatite, and ilmenite.

Each rock type in Mescalero 1 has a characteristic petrophysical signature. Gabbro is characterized by high density (3.0 gm/cc) and low total gamma activity (20 API), whereas quartz syenite has lower density (2.65 to 2.70 gm/cc) and high gamma activity (115 to 120 API). Tuffaceous sandstone exhibits very consistent and low values of gamma ray activity (~10 GAPI), and relatively high values of density (> 2.75 gm/cc). The dolomitic sandstone and the sandy dolomite show average values of total gamma ray of 40 GAPI and the density values varying from 2.75 to 2.8 gm/cc. The appearance of smoky quartz in these units may be due to uranium radiation damage, and uranium appears to be the responsible for the gamma ray response in these units. The arkose and rhyolite show similar values of gamma ray measurement varying from 125 to 200 GAPI .

In general, the more felsic units exhibit highest values of gamma ray measurement, and the more mafic units exhibit the highest density values. This suggests that the composition of the rocks plays an important role in the density and gamma ray response. As shown in figure 3, once the rock types and representative log characteristics were established for Mescalero 1, this criteria was used for the correlation of the Mescalero 1 well with the 1 State Mr. Jones well, from which no cuttings were available. These wells contribute new information about the Proterozoic development of the southwestern U. S., in terms of the petrologic assemblages, timing, and distribution of two basement suites, quartz syenite-granite (Panhandle Terrane) and the metasedimentary Debaca Terrane.

This study demonstrates that application of the oilfield-derived method of careful calibration of petrophysical interpretations with cuttings petrology results in a better understanding of the Proterozoic basement in east-central New Mexico.

REFERENCE:

Amarante, J.F. A., and Kelley S., 2001. Petrographic Characterization of the Proterozoic Basement in the deep Petroleum Exploration well Mescalero #1 within the Tucumcari Basin, Guadalupe County, New Mexico. (Unpublished)

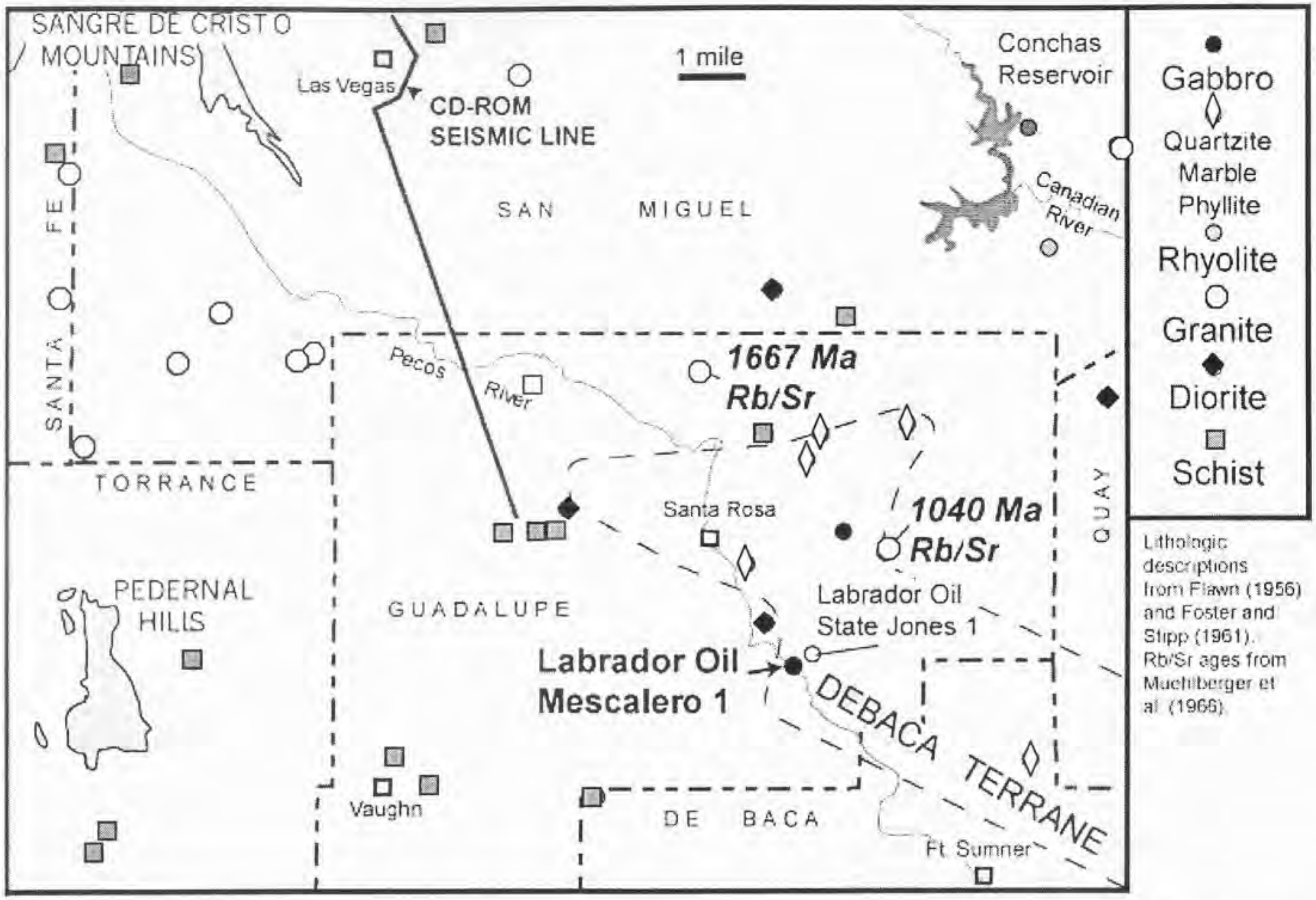

Figure1. Map showing the location of the Labrador Oil Mescalero No. 1, State Jones 1, and other wells drilled in the Tucumcari Basin region.

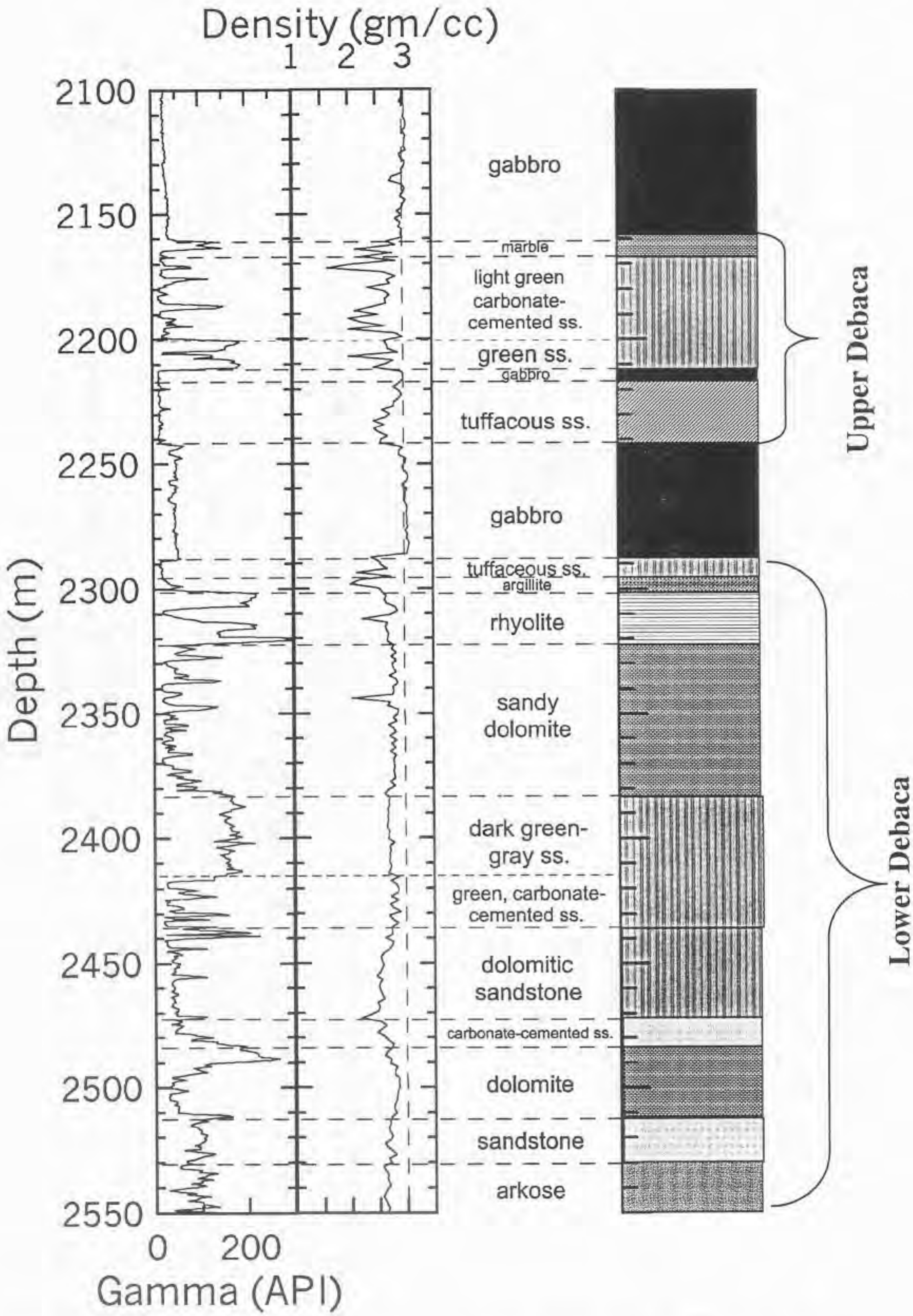

Figure 2. Proterozoic Debaca Sequence in Labrador Oil Mescalero #1.

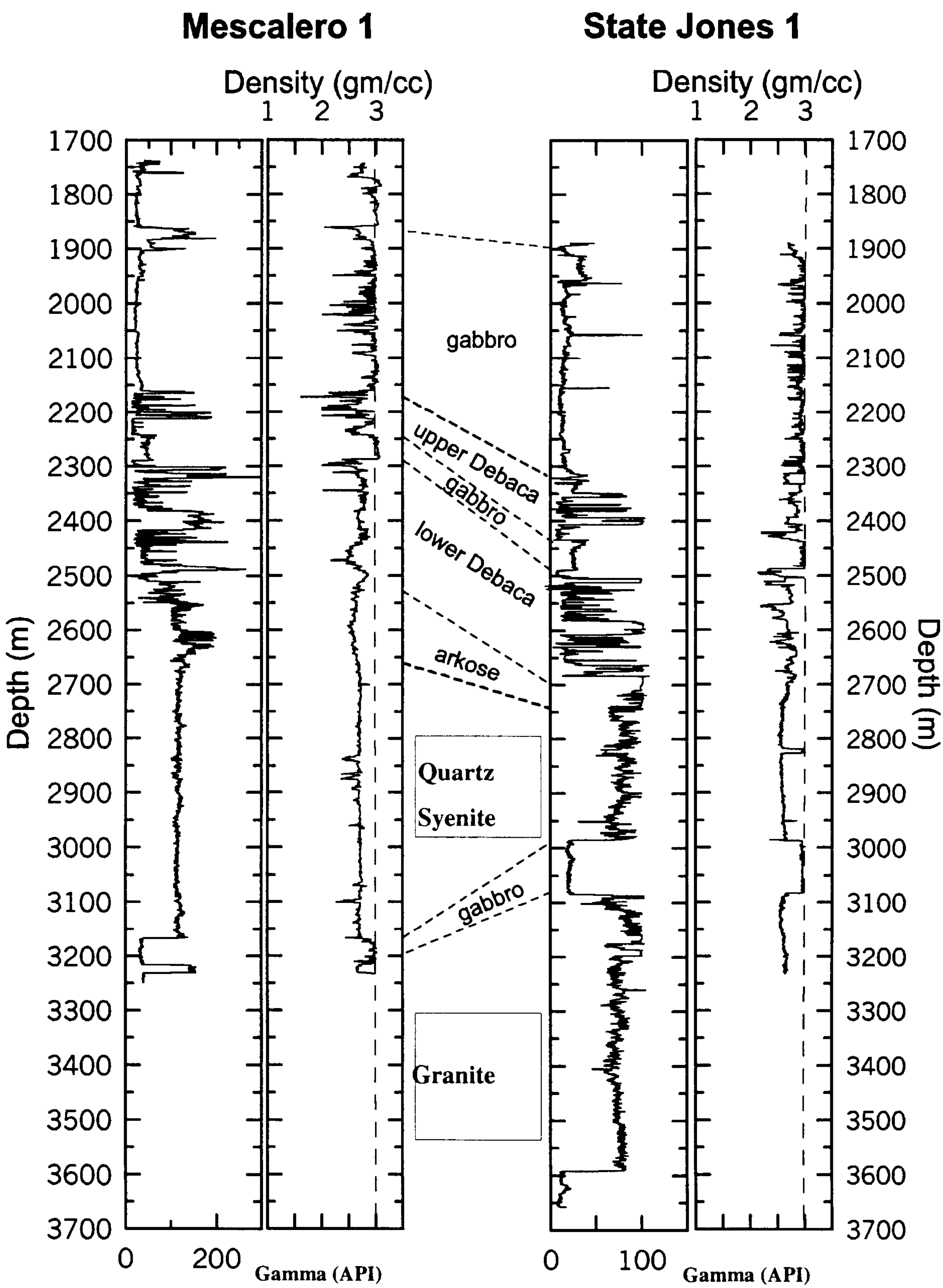

Figure 3. Comparison of the basement section of the well Mescalero 1 and the State Jones 1 well.