

GEOLOGICAL CHARACTERIZATION OF  
THE MADISON LIMESTONE (MISSISSIPPIAN) RESERVOIR,  
GARLAND FIELD, BIG HORN BASIN, WYOMING

By

A. Serdar Demiralin

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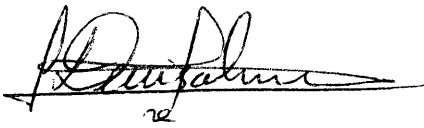
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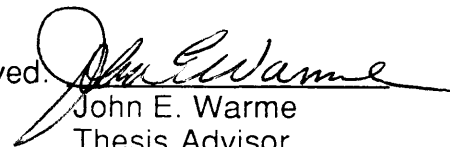
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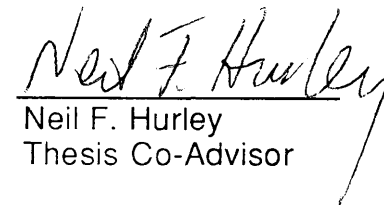
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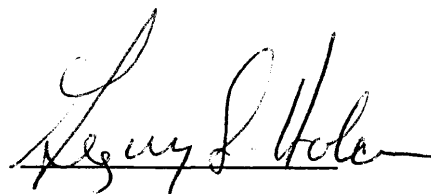
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## ABSTRACT

Garland field, an asymmetric anticline in the north-central Big Horn basin, has produced approximately 50 MMbbl of oil from the Madison Limestone and Darwin Sandstone. The Madison Limestone, which is approximately 1000-ft (300-m) thick, was geologically characterized to aid future oil-field development in Garland and nearby fields. A total of 1765 ft (538 m) of Madison Limestone cores from 10 wells and 395 thin sections from three wells were described and interpreted to determine sedimentology and diagenetic history. In addition, 75 ft (22.5 m) of overlying Darwin Sandstone were described from four wells that cored the Madison-Darwin unconformity.

The Madison Limestone was divided into 4 zones based on geophysical log signatures: 250-ft (75-m) thick A zone, 285-ft (86-m) thick B zone, 70-ft (21-m) thick C zone, and 180-ft (55-m) thick D zone. There are three shallowing-upward sequences that contain at least 10 subsequences. A typical sequence has skeletal/oid grainstones at the bottom, which grade up to dolowackestones and bioturbated dolomudstones that are overlain by laminated dolomudstones. Breccia intervals normally cap such sequences.

Approximately three-fourths of the Madison Limestone is dolomitized. Restricted-peritidal lithofacies are extensively dolomitized although open-shelf lithofacies are almost always partially dolomitized.

Three major breccia types are: (1) red clayey siltstone-matrix breccia, (2) clay-matrix breccia, and (3) dolomicrite-matrix mosaic and fracture breccia. These breccia types occupy three regionally correlatable intervals. The first two

breccia intervals probably formed during the post-Madison, pre-Darwin karst episode. Dolomicrite-matrix breccia might have been formed during a subaerial exposure before the end of Madison deposition. Clay-matrix breccia postdates dolomicrite-matrix breccia. The red siltstone-matrix breccia at the top of the Madison probably formed by karst processes whereas intraformational breccias may have formed by evaporite-dissolution collapse. Almost all clay-matrix breccias were formed by three successive phases of brecciation: (1) brecciation and cementation by pore-filling calcite, (2) anhydrite cementation, and (3) infiltration of clay matrix disrupting previous cements. Petrographic evidence suggests that brecciation continued, to a lesser extent, through later diagenetic episodes.

Almost all producing intervals are dolomites with intercrystalline, moldic and/or pinpoint vuggy porosity. However, grainstones with interparticle porosity exist, and they may form reservoir zones with the aid of fractures. Seventy-ft thick crinoid packstones of the C zone, and 40-ft thick clay-matrix breccias at the base of the A zone are devoid of porosity, oil stain, and fractures at the core scale. These appear to be permeability barriers to vertical flow. The dolomite and limestone intervals and individual lithofacies types correlate across the field. Tight limestone intervals do not seem to be efficient permeability barriers because they are commonly fractured.

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