Datashare XXX Supplementary Material 1

Case Study: Frobisher-Alida Sherwood-B1 flow unit on the northern Billings nose

By David M. Petty

The precursor sediment for the Sherwood-B1 dolostone flow unit formed in a lagoonal environment, labeled as facies II by Petty (1988, 2010, 2024). The lagoon developed landward from a facies III bar-island-shoal complex consisting of calcite-cemented grainstone and packstone, and seaward from a facies I sabkha-salina, anhydrite-dominated complex (Figure 1A S1). Porosity within the facies II dolostone occurs in a northeast-southwest trend, parallel to the paleoshoreline (Figure 1A S1). The Sherwood-B1 and B2 flow units are commonly 2-6 ft (0.6-1.8 m) thick. Sherwood-B lagoonal flow units occur elsewhere parallel to the shoreline, but they may have different log and correlation characters, suggesting that lagoonal flow units represent autocyclic beds within a fifth-order sequence.

The lagoonal facies consists of a diverse mix of grain types. The stromatolite sub-unit occurs in the landward (southeast) portion of the lagoon (Figure 1A S1) and consists almost entirely of stromatolitic, dolomitic boundstone. Rocks of this sub-unit commonly have 5–15% core porosity, but with permeability of less than 2 md, it typically forms poor reservoir-quality rock in vertical wells. The burrowed sub-unit occurs in the northwest (seaward) portion of the lagoon where burrowing disrupted some of the sediment, and both layered stromatolites and burrowed lithologies are present.

The SCA porosity-permeability data (Figure 1B S1) defines trends for burrowed and stromatolite samples. Burrowed, intraclastic-skeletal dolomitic wackestone with spherical, calcisphere-moldic vugs (Figure 1C S1) is a key reservoir lithology in the burrowed subfacies where core porosity and permeability are as high as 23% and 28 md *Ka* SCA. Most facies II oil-well completions (purple pentagons in Figure 1A S1) are located in the burrowed subfacies. The average dolomite crystal size is 23 µm in the burrowed subfacies, although sizes vary from 8 µm for individual stromatolite samples, to 32 µm for individual burrowed samples.

References Cited

Petty, D. M. 1988, Depositional facies, textural characteristics and reservoir properties of dolomites in Frobisher-Alida interval in southwest North Dakota: AAPG Bulletin, v. 72, p. 1229–1253.

Petty, D. M., 2010, Sequence stratigraphy and sequence boundary characteristics for upper Tournaisian (Mississippian) strata in the greater Williston Basin area: an analysis of a third-order cratonic carbonate-evaporite depositional cycle: Bulletin of Canadian Petroleum Geology, v. 58, p. 375–402.

Petty, D. M., 2024, A facies and flow unit approach to porosity occurrence in the Madison reservoirs (Frobisher-Alida and Tilston intervals) of western North Dakota: AAPG Search and Discovery Article #11382, 73 p., accessed July 27, 2024, https://www.searchanddiscovery.com/pdfz/documents/2024/11382petty/ndx_petty.pdf.html?q=%252BauthorStrip%253Apetty

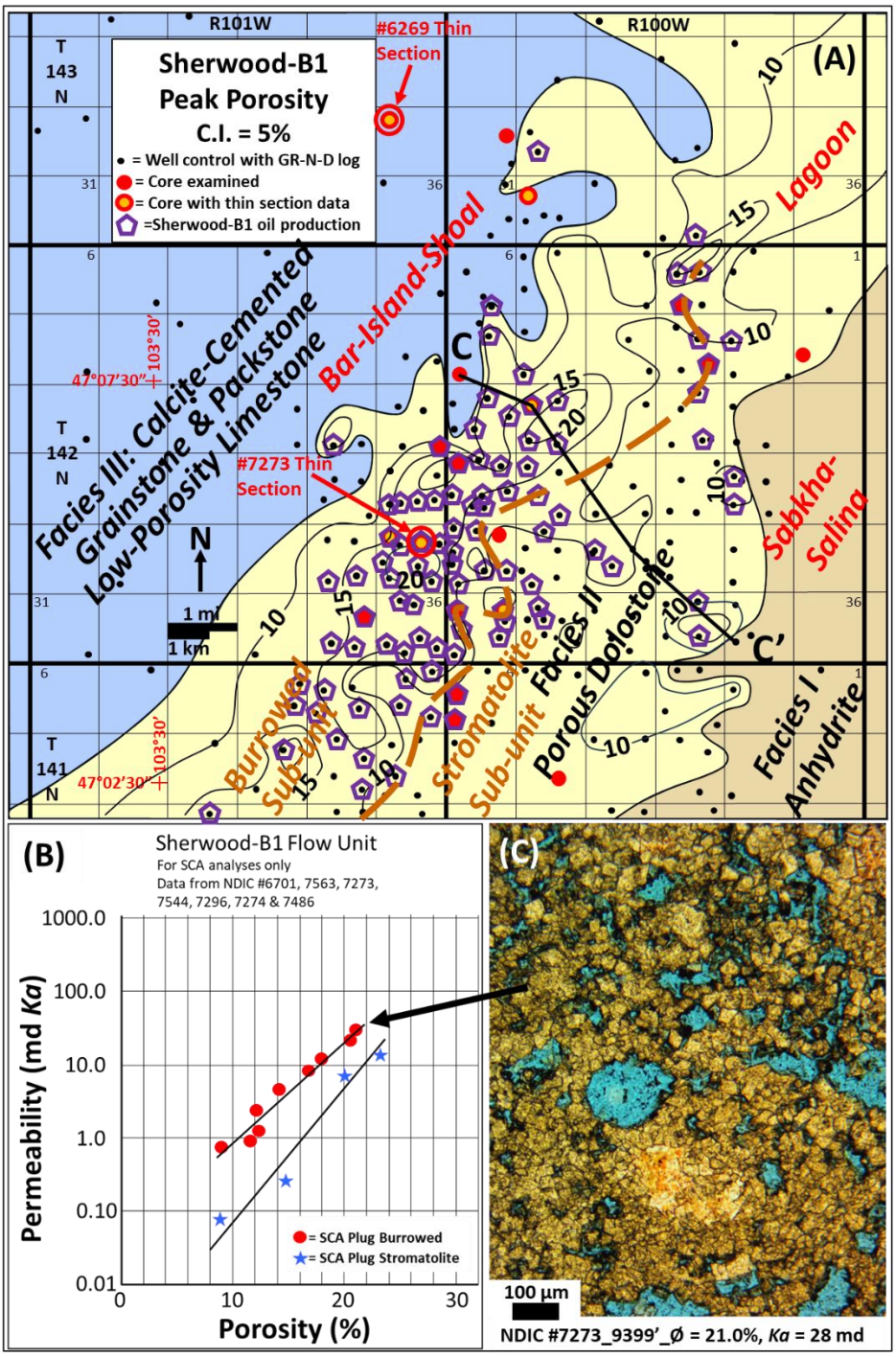

Figure 1 S1. A) Map of peak porosity for the Sherwood-B1 flow unit on the northern Billings nose. Brown-dashed line separates the stromatolite sub-unit from the burrowed sub-unit of facies II. B) Porosity-permeability (*Ka*) relationship for Sherwood-B1 facies II flow unit showing trends for burrowed samples and stromatolite samples. C) Thin section view of calcisphere wackestone in facies II, burrowed subfacies. Calcispheres have been leached out and are represented by spherical vugs in this sample.