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Travertine Macro- and Micro-porosity

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Travertine accumulations can be kilometers in lateral extent and many 10's of meters in thickness. The largest deposits mainly accumulated in lacustrine settings. Consequently, they have the capacity to form significant hydrocarbon reservoirs. Bacterially induced precipitates play a major role in the construction of a number of the hot water travertine lacustrine accumulations, for example, Bagni di Tivoli area, Italy, and Mammoth Hot Spring, Yellowstone National Park, USA. These deposits are primarily calcite, aragonite, or a mixture of the two minerals.

Well-documented examples of bacterial induced constituents include, bacterial shrubs, peloids, oncoids, and spherulites. Bacterial bodies have a negative charge on their external wall and this attracts positive ions, such as calcium. Carbonate species in the water column are attracted to the calcium, thus initiating precipitation of carbonate minerals. In this manner, bacterial colonies induce the initial precipitation of carbonate mineral matter in the area immediately surrounding the bacterial cells. The bacteria may continue to play a role in the precipitation of the carbonate or strictly abiotic precipitation may continue the growth of the bacterially induced seed crystals. Abiotic precipitation generally occurs in areas of very high supersaturation with respect to carbonate minerals.

Porosity occurs as "standard" depositional interparticle porosity, secondary porosity due to dissolution (Fig. 1), or as unconnected intraparticles porosity that results from the degradation of the bacterial bodies (Fig. 2). Depositional and dissolutional porosity can vary widely in pore size and in vertical and lateral abundance. Depositional porosity occurs as "normal" interallochemical space, for example as voids between equally sized spherulites or between adjacent shrubs along a horizon, to unique features such as vertical tubes in foam rock, a feature in which the pore space can readily exceed the volume occupied by rock. Horizons of abundant porosity can be surrounded by layers of dense carbonate rock that lacks noticeable macroporosity.

Bacterially induced precipitates commonly display microbiotic porosity (Fig. 2) in these constituents. This is because bacterial bodies make poor fossils. It is not uncommon for the cell wall to break and the fluids within the cell to escape. The cell then collapses resulting the formation of a micron-sized pore. This has been observed under laboratory conditions and can occur within a matter of days after precipitation of the carbonate mineral surrounding the cell. This microporosity is generally totally within the biotically induced mineral precipitate, i.e., appears to be unconnected porosity. This microporosity is commonly well displayed in scanning electron images (SEM) of the bacterial shrubs and oncoids, however, it is not evident in thin

section observation. It is possible that this microporosity can affect bulk physical measurements of the travertine

Porosity within travertines can be very complex and difficult to predict.

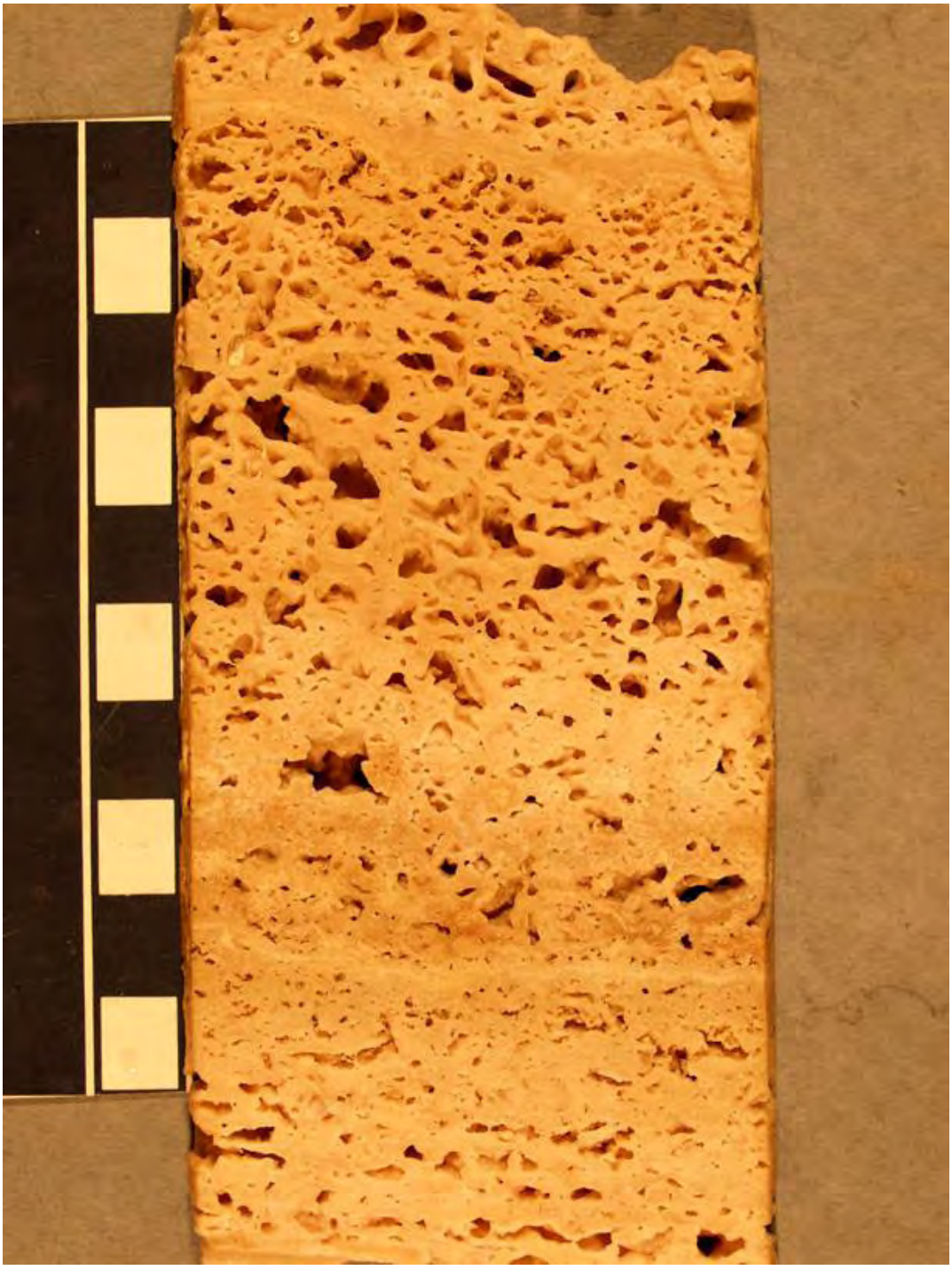

Figure 1: Core at 16.4 m down from the top of Mammonth Hot Springs accumulations, Yellowstone National Park, Wyoming, USA. Core displays both primary depositional porosity as well as secondary dissolutional pore spaces. Each box on the scale is 1 cm.

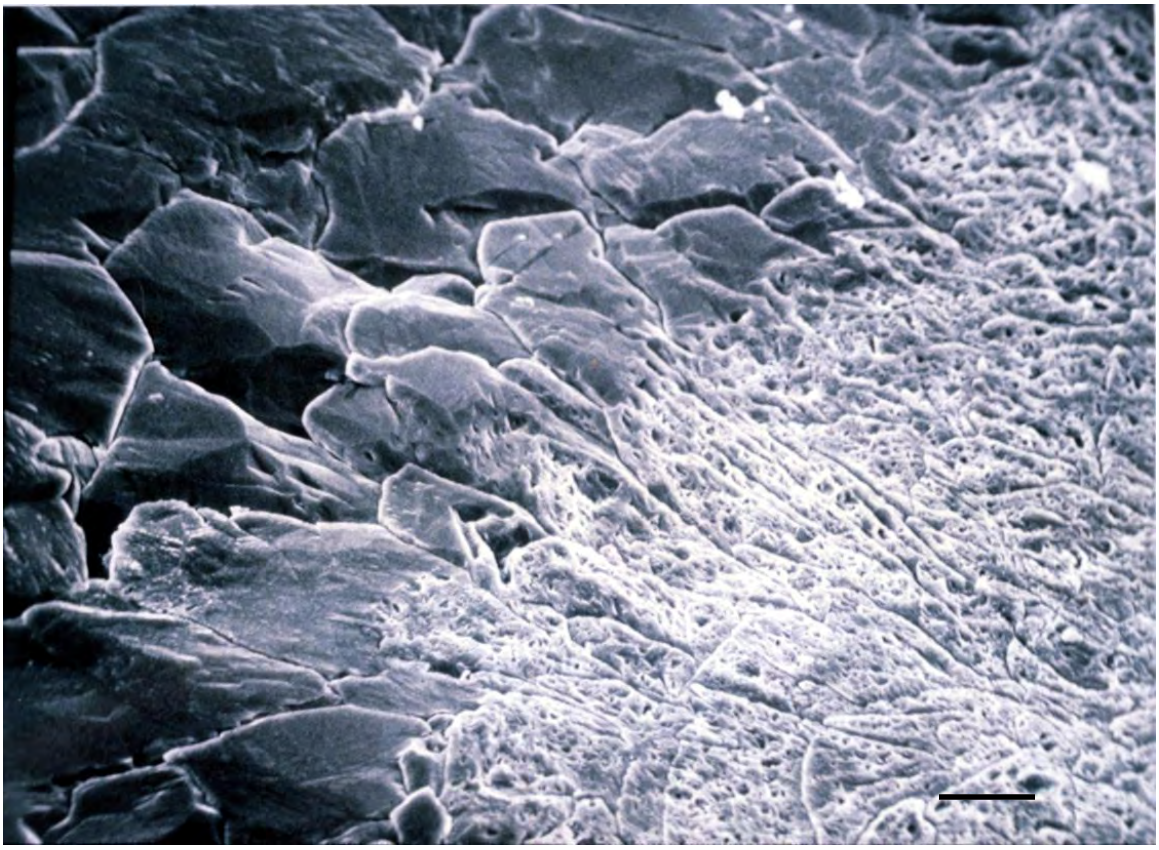

Figure 2: Scanning electron micrograph (SEM) of the edge of a lightly HCL etched bacterial oncoid on the righthand side of the picture with spar cement radially overgrown on this allochem. Former sites of the bacterial bodies are now represented by holes, i.e., the bacteria have decayed. Observe that no micropore holes are present in the spar cement. Bar scale equals 10 microns.