CONCRETIONS AS COMPACTION PROXIES IN THE VACA MUERTA (NEUQUÉN BASIN, ARGENTINA)

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PROJECT OBJECTIVES

- To measure the compaction in lime-rich mudrock using early cemented concretions as a pre-compaction reference.

PROJECT RATIONALE

Concretions retain original (or close to original) sediment thickness due to their early, rapid, and pervasive pre-burial cementation near the sediment-water interface. This preservation of original sediment thickness is confirmed by petrographic studies that show a lack of compaction in mud peloids and very delicate skeletal grains (Fig. 1A). In addition, stable isotope data from concretion cements suggest early, pre-compaction seafloor cementation driven by bacterial sulfate reduction through diffusion with normal seawater (sulfate, Ca^{2+} supply).

PROJECT DESCRIPTION

The compaction of the surrounding host sediment, in this case the fissile mudstones around the concretions, is very clearly visible in strain shadows around the nodular concretions recovered in core (Fig. 1B) and seen in outcrop (Fig. 2). From the initial sediment thickness (T_0) compared to the compacted sediment in the host sediment (T_c) we can calculate compaction strain using the following relationship:

$$\frac{T_0 - T_c}{T_0} = \varepsilon \qquad (1)$$

This was done in a preliminary attempt for the concretion shown in Figure 1, where a compaction strain of -0.914 (91.4%) was calculated. Obviously, since this has only been done so far on one single concretion it is hardly

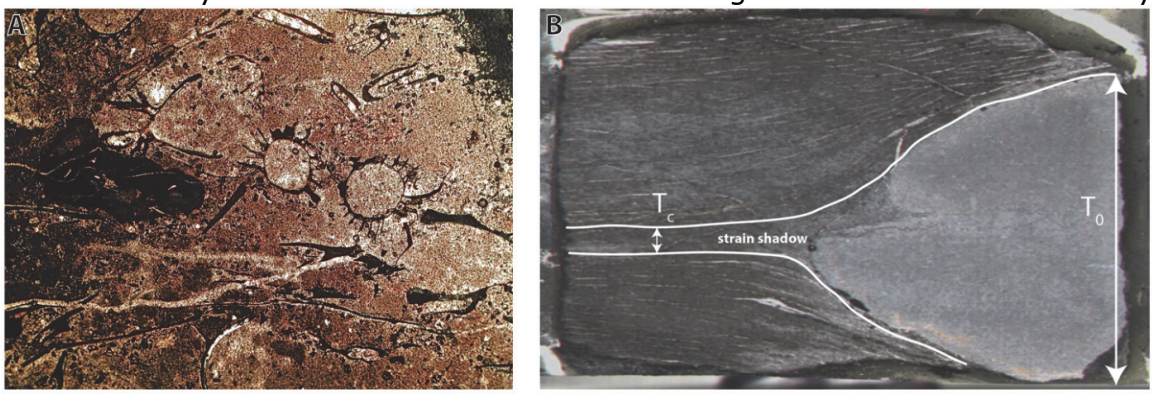

Figure 1. (left) Example of the early, pervasive calcite cementation in Vaca Muerta concretions. Delicate large radiolaria (center, center right) are preserved with extensive ornamentation. (right) Initial sediment thickness T_0 and sediment thickness after compaction T_c can be used to calculate compaction strain ε. Puerta Curaco section short core SC-PC3-129.

representative. Based on the extensive dataset available from the Vaca Muerta and especially basinal outcrops, we should be able to obtain more results in order to assess a statistically representative compaction strain parameter.

Figure 2. Typical isolated concretions in the Vaca Muerta Formation that can be used to measure the compaction strain between the concretions and the adjacent mudrock.

Compaction strain can be used to approximate paleoporosity using the following relationship (Jacob, 1949):

$$\phi_{palaeo} = \frac{\phi_0 + 100\varepsilon}{\varepsilon + 1} \qquad (2)$$

Porosity is expressed in volume percent. The results depend on reasonable estimates of Φ_0, which is porosity at the onset of compaction. Such a value could be approximated based on textural analysis of the concretions (diagenetic carbonate in void spaces, volume percent of carbonate cement in pores at time of concretion growth, Raiswell, 1971). We have estimated a value of >40% in fine sand concretions, a very general estimate. However, higher original porosity values (~70-80%) can be expected for modern marine clay deposits (lime mud and clay minerals) close to the water-sediment interface (Velde, 1996). An initial porosity value of 40%, is likely conservative, as many Vaca Muerta concretion thin section estimates are >60% cement. SEM images from strain shadows could also give us clearer evidence about porosity values at the onset of compaction. Obviously, this is only valid if we can expect a negligible amount of compaction in the strain shadow of the concretion.

EXPECTED RESULTS

This project will assemble a dataset on the compaction properties of lime-rich mudrock in deposits that contain variable amounts of organic matter.

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