ASSESSING THE THERMAL HISTORY OF THE NEUQUÉN BASIN USING CLUMPED ISOTOPES

Peter K. Swart, Chaojin Lu, Ralf J. Weger, and Gregor P. Eberli

PROJECT OBJECTIVES

- Assess the geothermal history of the Vaca Muerta Basin using the Δ_{47} proxy.

PROJECT RATIONALE

The Vaca Muerta Basin, located in Central Argentina is a mixed carbonate-siliciclastic mudstone succession with interbedded limestone, mass transport deposits and volcaniclastic beds. Its lower portion is organic-rich and was deposited under anoxic conditions. This interval serves not only as the source rock for hydrocarbon deposits in the Neuquén Basin, but also is an unconventional play (Minisini et al., 2020). The thermal history of the basin, which is important for understanding the maturation of the organic material, has been ascertained using a combination of fluid inclusions (Ukar et al., 2020) and clumped isotopes of calcite veins known as 'beefs' (Weger et al., 2019).

While the study of Weger et al. (2019) was pivotal in determining the formation temperature and origin of the beefs, these samples do not provide the burial history throughout the 800 m of section. We compare the Weger et al. (2019) data to the modeled temperatures using the models of Henkes et al. (2014) and Stolper and Eiler (2015) (Fig. 1). Although the Weger et al. (2019) data is broadly in agreement, additional measurements need to be made which are not biased towards the calcite within calcite veins. To rectify this, we propose to analyze samples throughout the entire section.

WORK PROPOSED

We have collected over 2000 samples from ~ 800 m of section and constructed a composite section extending from the Early Tithonian to the Early Valanginian (149-135.5 Ma). The carbonate content of these samples varies, but generally increases towards the top of the section and mirrors the transition from anoxic to more oxic conditions. There are also a few intervals that contain dolomite. Our approach will be to take between 20-30 bulk samples throughout the entire section as well as samples from dolomitized intervals and fractures. These will be processed for the measurement of their Δ_{47} and Δ_{48} values using methods established at the University of Miami (Murray et al., 2016; Swart et al., 2019). The Δ_{47} values will be modeled using various approaches presented by a number of workers (Hemingway and Henkes, 2021; Henkes et al., 2014; Stolper and Eiler, 2015) to determine the burial history of the basin. As dolomite and calcite have different blocking temperatures, we can use these to tune the burial and diagenetic history.

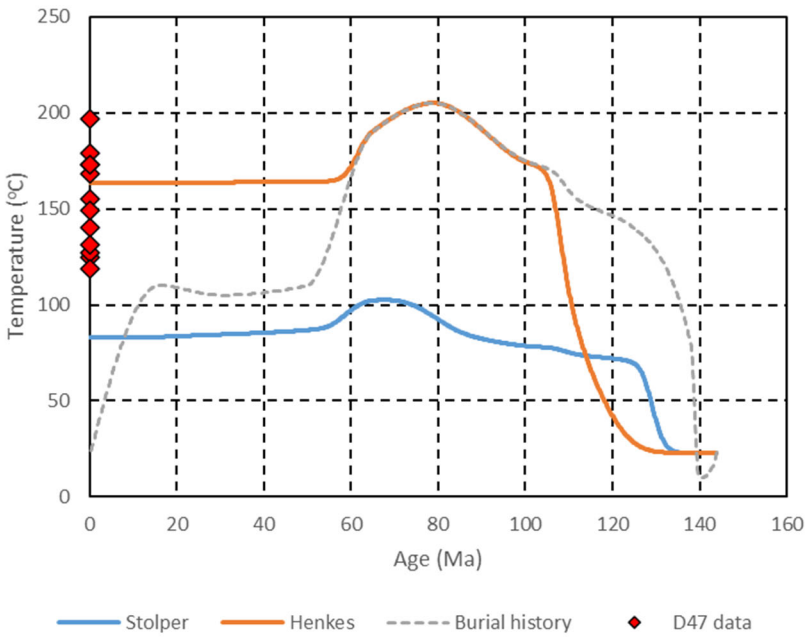

Figure 1: Estimate of the temperatures expected in the calcite samples using two of the solid-state models compared with the temperatures estimated using the clumped isotope data from Weger et al. (2019).

SIGNIFICANCE

The measurement of the Δ_{47} values from the Vaca Muerta will enable us to compare the burial history of the Vaca Muerta calculated using fluid inclusions with that estimated from clumped isotopes. The addition of the Δ_{48} proxy will allow a comparison of its performance as an indicator of solid-state reordering relative to the values obtained using Δ_{47}. This will help us understand the maturation in the basin.

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