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Isotope stratigraphy ($^{87}Sr/^{86}Sr$, $\delta^{18}O$, $\delta^{13}C$) of the Sorbas basin (Betic Cordillera, Spain): Paleoceanographic evolution across the onset of the Messinian salinity crisis

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ABSTRACT

The Sorbas basin is a reference sector of the Mediterranean basin for the definition of the onset of the Messinian salinity crisis straddling the transition from the open marine deposits (Abad marls) to the Primary Lower Gypsum (Yesares Formation) during the first stage of the crisis, between 5.97 and 5.60 Ma. Because of its proximity to the Atlantic gateway, the Sorbas basin is pivotal for the study of the oceanographic evolution that led to the most dramatic environmental event in the Mediterranean Sea. We measured the carbon ($\delta^{13}C$), oxygen ($\delta^{18}O$) and strontium ($^{87}Sr/^{86}Sr$) isotope ratio of 50 samples of planktonic foraminifera, mollusk shells, gypsum and carbonate sediments from the Abad and Yesares Members (Turre and Caños Formation) in the Perales, Hueli, Los Yesos and Rio de Aguas sections. Our results show a long-term trend with most of the values plotting within the range of the global ocean strontium isotope curve and distinct short-term fluctuations on precessional time scale. The investigated geochemical proxies suggest that these oscillations reflect significant input of continental waters into the basin during the humid phase of a single precessional cycle. This implies that the Western Mediterranean did not experience a main disconnection from the global ocean water before and during the first stage of the Messinian salinity crisis and that different Milankovitch forcings played a significant role in determining the seawater geochemistry.

1. Introduction

The Messinian represents a crucial period for the evolution of the Mediterranean basin, which experienced major geological, hydrological and oceanographic changes with catastrophic consequences on its aquatic ecosystems. The study of these upheavals has not yet led to a full comprehension of the succession of events that occurred since about 6 Ma. One open question regards the timing and the modalities of the paleoceanographic changes occurring during the upper part of the pre-evaporitic phase up to the onset of evaporites precipitation (Roveri et al., 2014a). According to the three stages evolutionary model proposed by Roveri et al., 2014a (Fig. 1A), during the Messinian salinity crisis (MSC) the Mediterranean was affected by series of climate-induced environmental modifications characterized by the deposition of peculiar geological units in terms of paleoenvironmental, sedimentological and geochemical signatures (Müller and Mueller, 1991; Flecker et al., 2002; Flecker and Ellam, 2006; Roveri et al., 2014a, 2014b). The MSC onset in the Mediterranean occurred synchronously at 5.971 Ma (Manzi et al., 2013), following the progressive restriction of the Mediterranean circulation and the establishment of water column stratification starting at 7.12 Ma (Kouwenhoven and van der Zwaan, 2006; Sierro et al., 2001). The latter is recorded basinwide by the cyclical and orbitally-controlled deposition of marls, diatomites and organic rich sediments in open marine settings in the Western (Abad Member, Sorbas basin; Sierro et al., 1999, 2001, Krijgsman et al., 2001), Central (Tripoli Formation., Caltanissetta basin; Bellanca et al., 2001; Blanc-Valleron et al., 2002) and Eastern Mediterranean (Pakhna Formation, Cyprus; Gavdos basin, Greece; Krijgsman et al., 1999, 2002; Manzi et al., 2016).

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