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Sunspot and ENSO-like cyclicity in lower Messinian shallow-water primary evaporites from the Marche Region (central Italy)

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During the Messinian salinity crisis ($\sim$5.5 Ma) the Apennine foredeep had marginal basins where shallow-water primary evaporites were deposited and deeper basins where re-sedimented evaporites and Corg-rich shales accumulated under relatively deep-water conditions. In several stratigraphic sections from the Marche region, these facies alternate in a cyclical pattern. In the expanded Peglio section 2-3 metre-thick cycles are composed of four members: a) primary evaporites; b) re-sedimented evaporites and arenites; c) Corg-rich shales; d) diatomites, reflecting a lateral migration of facies controlled by sea-level changes. Thin sections and slabs from the shallower-water intervals (member a), composed of varve-like couplets ($\sim$ 0.5 mm thick) of gypsum and Corg-rich shale, have been digitally analysed using a variety of techniques to yield time series records of couplet thickness. A variety of spectral techniques, including traditional FFT, Multi Taper Method, and Singular Spectrum Analysis treatment of the evaporitic record reveals significant spectral peaks with periods of 11 and 4-6 couplets. Based on the similarity with varve layers and other laminated evaporites, we suggest that each laminae couple represent one year. Independent dating is not possible in this case, but if the larger cycles represent precessional cycles of approximately 20 kyr, the thicknesses of these couplets are appropriate for annual layers.

Under this assumption, the periodicities observed would correspond to the sunspot cycle and El Nino-Southern Oscillation (ENSO); present-day phenomena known to produce rainfall and temperature changes. Therefore, we propose that ENSO and the solar cycle may have controlled the variations in couplet thicknesses by varying the evaporation/precipitation ratio during the deposition of the Messinian evaporites.