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Pliocene mangrove deposits from the Vera Basin of Southeast Spain

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Pliocene sediments of the Cuevas, Espirítu Santo and Salmerón formations exposed within the north-central regional of the Vera Basin of Southeast Spain record a transition from marine through to continental conditions. An integrated sedimentological and palaeontological study of the transition, exposed in a $\sim$50m thick succession in Barranco del Tomate, 3km southwest of Cuevas del Almanzora town, has revealed evidence for mangrove conditions. Mangroves represent a unique assemblage of fauna and flora that occupy tidal saline wetlands within sheltered tropical and subtropical climates. The discovery of fossil mangrove deposits from the Vera Basin provides a new and exciting insight into localised environmental conditions which has broader implications for understanding regional palaeoclimate and climate change in the western Mediterranean during the mid-late Pliocene.

The Barranco del Tomate section reveals five key facies associations (FA). FA1 occurs within the lowermost 11m of the section and corresponds to the Cuevas Formation. It comprises bluish-grey coloured siltstones and mudstones that are extensively bioturbated. Facies contain high diversity macro- and micro-fossil assemblages typical of an outer shelf environment ($<$100m water depth). Mid to upper parts of the section (11-47m) are dominated by FA2-4 of the Espirítu Santo Formation. Overall, the facies associations record sea-level fluctuations but track an overall decline in water depth within a near shore coastal setting. FA2 is characterised by 8m of laminated siltstones and mudstones within the lower part of the section. Sediments were deposited under low energy anoxic conditions in a lagoon setting ($<$40m water depth) occupying pro-

tected areas in-between a series of Gilbert-type fan-delta lobes. Abundant mangrove flora (e.g. viviparous seedlings [*Hypocotyls*] and tetramerous flowers [*Rhizophora*]) and fauna (e.g. Clupeidae fish) are exceptionally well preserved as a fossil lagerstatten. Microfauna are dominated by buliminid and discorbid foraminifera and *Cyprideis mehensi*. FA3 is characterised by 20m of pebble-gravel sandstones and conglomerates reflecting deposition within a high energy littoral beach setting, possibly reflecting sediment reworking from adjacent fan-delta lobes. FA4 occurs within the upper part of the section and comprises mudstones, siltstones and sandstones deposited within a low energy mangrove bearing lagoonal setting. Microfauna are dominated by euryhaline *Ammonia beccarii* and *Cyprideis mehensi*. Mudstones that contain cerithiid and turritelid mud creepers, potamid mud whelks and ellobiid gastropods, combined with oysters displaying pneumatophore (mangrove root) imprints are strong evidence for mangrove colonization. FA 5 occupies the uppermost portion of the section and corresponds to the Salmerón Formation. It comprises reddish-grey coloured siltstones and sandstones that contain common carbonate nodules (weak calcic soils?). These sediments reflect deposition with the distal parts of a series of coalescent alluvial fans, marking the onset of semi-arid continental conditions.

Modern mangroves typically occur in tropical-sub-tropical regions 30˚N-S of the equator where the warmest month water temperature exceeds 24˚C. The Pliocene palaeogeographic position of the Vera Basin would have been not too dissimilar to its current location at $\sim$37˚N. This suggests an unusual northwards extension of mangrove supporting climatic conditions into the western Mediterranean. Interestingly, other studies of Pliocene marine sediments from nearby sedimentary basins in SE Spain suggest more temperate climatic conditions.