ORIGIN AND POTENTIAL OCCURRENCE OF MESSINIAN POTASH ROCKS

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A Miocene rock salt sequence is known from extensive salt beds underneath the Balearic, Ionian and Levantine Seas, and also as graben fill under selected areas of the Tyrrhenian and Aegean Seas. Only under the Levantine Sea have two major salt sequences been recognized (Finetti and Morelli, 1973). The rock salt sequence is accessible on land in Sicily: The updip edge of the Caltanissetta basin, that extended in Miocene time southwestward well beyond the present outline of Sicily, contains two separate potash horizons interbedded with rock salt. These potash deposits contain a variety of potassium sulfate minerals.

Concentration of a marine brine to potash saturation can occur only in lagoons that are severely restricted in their water exchange with the open sea, and thus maintain an extremely high ratio between surface inflow and bottom outflow (Sonnenfeld, 1984). The Caltanissetts Basin was likely not the only lagoonal depression that formed during Messinian time in the Mediterranean region. Since potash minerals precipitate from a brine much more concentrated than required for halite saturation, potash mineral occurrences are conventionally depicted as terminal deposits located in the deepest parts of a basin, where residual bitterns are concentrated before an ultimate desiccation of the depression. However, potash deposits are almost always interbedded with halite deposits, rather than occurring on top of them, suggesting an oscillating brine concentration that reverts to values below potash saturation well before evaporite precipitation ceases. Furthermore, a sodium chloride brine containing at least 35 percent potassium chloride becomes lighter as it cools; a reduction in density is concomitant with a reduction in solubility. Thus we find thick potash beds only towards the flanks of basins, on sea floor slopes and towards shoals. Therefore, the sites of potential occurrence of Mediterranean potash deposits are considered to be not beneath the Ionian or Levantine Seas, but underneath the flanks of these seas, in subsidiary inlets along the margin of the deeper depressions, or near marginal shoals and island chains.

Without exception the primary marine potassium salts are chlorides of potassium, or of potassium and magnesium. Percolating waters can alter these to a great variety of anhydrous or hydrated K- and K-Mg-sulfates. Such sulfatization did not affect all potash basins; it is unknown in pre-Permian or in Mesozoic evaporites. On the other hand, extensive, but not always complete sulfatization is common worldwide in Permian and Miocene evaporites. Interludes of potash sulfatization coincide with excursions in the sulfur isotope curve away from

bacterial influence. This suggests that some, as yet unexplained, temporary mass depletion of the flora of anaerobic sulfur bacteria occurred in evaporite basins at these times in the earth's history. It also implies that oxygenated, sulfatic waters were then able to penetrate into potash beds sandwiched between halite units. Sulfatic brines do not percolate very great distances into the subsurface before being stripped of their sulfate ions; sulfatization is thus another argument for a nearshore sites of deposition for potash beds. Mass balance calculations preclude consideration of the dehydration of surrounding gypsum beds as an adequate source of such sulfatic brines (Sonnenfeld, 1984). Since chloride salts lose their permeability rather rapidly even under a very thin overburden, either the sulfatization occurred very early or discrete permeability paths were kept open for some time.

Flash floods produce widespread dispersion of clays along the interface between brine and inflowing meteoric flood waters; they eventually descend through the brine to create clay layers of uniform thickness that retain moisture even after salt precipitation resumes. Consequently, the clay laminations do not lose their porosity and permeability as rapidly as the growing halite overburden. It is inferred that shale intercalations within the evaporite sequence have acted as such conduits for percolating brines long after the burial of the deposit. They have not only delivered meteoric waters into basin-margin carbonates and sulfates (for which isotope data have frequently been described from Sicily), but also permitted the penetration of sulfatic surface waters deep into the sequence of chloride deposits.

References cited:

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