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Eutrophication and Trace Metal Cycling in the Salton Sea: A Century of Industrial Impact

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The Salton Sea is California's largest lake, covering almost 330 square miles of low-lying, inland desert in the Imperial and Eastern Coachella Valleys. Despite the enormous surface area of the lake, it has a maximum depth of only 10.5 meters (an aspect ratio almost identical to that of a sheet of A4 paper), and the region is subject to extreme heat in the summer. Functioning more like an industrial evaporation table, the lake would be very small if not for agricultural and municipal wastewater. Combined, these sources represent the overwhelming majority of annual inflows, with agricultural return flow making the largest contribution by far. This has remained the case for over a century, leading to a host of devastating and predictable consequences—all exacerbated by the fact that the Salton Sea is a closed basin.

Over the past hundred years, the salinity of the Salton Sea has risen steadily, while the lake level has experienced significant fluctuations, both up and down. Due to the extremely low angle of the lakebed, small changes in water level lead to dramatic shifts in the location of the shoreline. Over the past five years, for example, tens of thousands of acres of lakebed have been exposed due to water transfer agreements between local water authorities that have reduced inflow. In addition to the ecological devastation that has occurred as the lake has become saltier, the recent exposure of vast areas of lakebed has created an ongoing public health crisis linked to dust emission.

Hypereutrophication has been a persistent feature of the lake over time, as the primary source of inflow is unchecked agricultural runoff. Coupled with intense thermal stratification in the summer, high rates of algal and bacterial production in the upper meters drive respiration and anoxia below, leading to efficient recycling of nutrients and a host of consequences for the cycling of sulfur, iron, and redox-sensitive trace metals. Sulfate levels in the Salton Sea are very high (~300 mM), and the water column regularly becomes sulfidic. Most of the iron that enters the basin is sequestered into sediments as iron-oxides within the river deltas. The small amount of iron that makes it beyond quickly precipitates as iron-sulfides, leaving sediments throughout the vast interior of the lake very low in iron. Concentrations of redox-sensitive trace metals within sediments vary spatially and with depth in ways that reflect the redox stratification and overall geometry of the lake, the distribution of iron, and the history of accumulation and sequestration that has ocurred over time within a closed basin. This study explores these relationships through the integration of geochemical data from sediment cores and water samples from multiple transects within the basin, as well as major tributaries, building toward a comprehensive model of

trace-metal cycling within the lake prior to and since the influence of agriculture and industry in the region began.