Geothermal Resources in the Imperial Valley of California

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Abstract

The Imperial Valley is a major rift valley characterized by unusually high heat flow and large quantities of water in storage in the thick fill of alluvium provided by the sediments of the delta of the Colorado River. The inventory of hot water appears to be sufficiently large that if used for water desalination it might add several million acrefeet of new water to the resources of the lower Colorado River basin. This distilled water would serve to lower river salinity and provide extra water to help meet the U. S. - Mexico treaty commitments. A major fraction of water desalination costs lie in the cost of energy and are related to desalination technology which is directly related to water chemistry. The discovery of low salinity geothermal waters in the Imperial Valley opened th possibility for a major breakthrough in lowered water desalination costs.

We have tried to develop a broad understanding of the origins of the waters of the Imperial Valley and how natural recharge occurs.

The chemical composition of the waters of the central portion of Imperial Valley basin waters, while not that of present surface flow of the rivers, nevertheless does have a close affinity to Colorado River water. No sea water seems to be present in the valley although marine sediments appear to occur on basement on West Mesa and on basement to the east in Arizona south of Yuma.

Low salinity waters dominate the basin hydrology and waters as saline or more saline than sea water appear to be restricted to the immediate area of the Salton Sea.

The isotope work of T. Coplen makes it possible to determine the relative contribution of precipitation runoff from California watersheds and from Colorado River water. Both sources are significant. The Colorado River water in aquifers from 100-400 m appears to have been entrapped from a relatively homogeneous basin which was subject to substantial evaporation. Its original source was snow melt water from the Colorado River.

Five types of waters, none of them sea water, were recognized by their salt geochemistry. Bromide/chloride data are particularly effective in resolving

different types of water masses. The bromide/chloride data agree with the isotope data and identify rainfall and precipitation runoff from the high mountains to the west. Modern Colorado River water is easily recognized by its salts and two types of ancient Colorado River waters from previous lake stage are proposed on the basis of the bromide/chloride data. One old lake occurring during the pluvial stage associated with the last Ice Age is proposed to account for much of the water in artesian aquifers. Another younger lake stage, possibly with Lake Cahuilla affinities is also suggested.

Mountain runoff waters can be distinguished in the subsurface by their relatively lower salinity and high bicarbonate concentration, and their heavy isotopic composition.

Revised fluid reserve calculations based on additional porosity data continue to show that the low salinity water resources of the Imperial Valley may exceed two billion acre-feet.

The oceanic plate tectonic model is modified in the Imperial Valley by the evidence of a series of complex blocks with the generation of both tensional and compressional features in the valley. Major strike slip faults dominate the tectonic fabric but conjugate features increase complexity by a large degree and a major amount of work will be needed before any geologically sound structural models can be generated.

Xenoliths within the obsidians at the volcanoes at the south end of the Salton Sea provide samples of the basement under the Imperial Valley. These xenoliths include partially remelted granitic rocks, fragments of basalt, green-schist, and baked shale and sandstone. This is taken as evidence that the basement in the valley consists in part of partially remelted granite. This would render basement plastic and readily deformed. The source of the heat is suggested to be derived from basalt that comes into the basement and deeper sediments from below. This upward movement of basalt along a spreading zone is the continental equivalent to a sea floor spreading area. In the continental case the insulating blanket of wet sediment retains the heat and appears to produce a major geothermal resource.

The geothermal resources of the Imperial Valley are the aggregate of the thermal energy of the large inventory of subsurface water heated by the complex mix of intrusive phenomena. The net result is to generate a polygenetic geothermal resource of very large dimensions.

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