Economic Geology of Death Valley

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Death Valley has been a source of mineral wealth ever since Anglos first passed through the area on their way to the California goldfields. One of the original '49ers, the namers of Death Valley, picked up a glittering piece of rock during his ordeal, which a gunsmith later declared to be solidly veined with silver. No-one has ever found the whole hill of said rock, which the finder "remembered" seeing as he picked it up... By the 1870s Death Valley was part of the boom-and-bust Wild West, with gold, silver, copper, and lead deposits spawning what would soon become ghost towns.

Metals worth millions of dollars were soon excavated. However, unfashionable borate minerals soon became the economic driver. Estimates of the total value of the original borate deposits are on the order of billions, rather than millions of dollars. Death Valley and other regions in Southern California contain the major portion of the world's reserves of borates. Borates are oxides of boron (B), the fifth element in the periodic table, which lies between beryllium and carbon, and in the same chemical group as aluminium. Hence borates generally contain the component B_2O_3. Borates are industrially important, being used as a component of glass and pottery glazes in the ceramics industry, as a solvent for metal-oxide slags in metallurgy, as a flux in welding and soldering, and as a fertilizer additive, a soap supplement, a disinfectant, a mouthwash, and a water softener. Common borate minerals include colemanite ($Ca_2B_6O_{11}.5H_2O$), ulexite ($NaCaB_5O_9.8H_2O$), and borax ($Na_2B_4O_7.10H_2O$), which are all hydrated and all contain alkali metals. The usual apparatus of the chemical industry is used to refine the borates, though early companies were unable to get their refined product to crystallize from solution in summer temperatures exceeding 120F...

Historically, American borate mining can be divided into three phases: playa surface mining (1860 - 1890), underground mining (1890 - 1957), and open pit mining (1957 - present). The first phase gorged on surface deposits of those borates which were easiest to process, the second devoured large, concentrated subsurface deposits, and the third is in the process of finishing off the large volume, low grade deposits. Death Valley has played a major role in all three phases.

The economically important borates deposits in Death Valley were formed by precipitation from a permanent or semi-permanent lake. Large-scale borate formation in lakes requires several factors to be in operation simultaneously. Borates have relatively high solubilities, so an arid environment helps produce supersaturation in a lake and allows the borates to remain solid after precipitation. An interior drainage system with a relatively small drainage area (to reduce borate dilution by competing ions) are required. The boron source is usually a hot spring associated with volcanism. The arid environment is provided by the mountains to the west blocking marine moisture and basin and range topography forms the interior drainage. Add a dash of volcanism, et voila, borates.

Refining Borax

1) In the first step of refining, crushed ore is dissolved through steam addition and agitation. Insoluble rocks, sand and other solids are removed using screens.

2) Next, the saturated borax solution is pumped into large settling tanks called "thickeners" where remaining fine particles settle to the bottom of the tank leaving a clear, hot borax solution on top.

3) Crystals of borax pentahydrate and borax decahydrate form as this hot solution is cooled in the crystallizers.

4) The newly formed borax crystals pour out onto special fabric filters where they are also washed to ensure their purity. Water is drawn away from the crystals by a vacuum underneath the filter.

5) After this washing, the crystals are transferred to the dryers. These large rotating dryers use hot air to dry the borate crystals.

6) Dry borate crystals exit the dryer and drop onto a conveyor belt. The refining process is complete. The refined borates travel by conveyor to one of two places - storage or packing.

References

www.borax.com
www.britannica.com
Barker JM and Wilson JL, Borate deposits in the Death Valley region (1975) Nevada Bureau of Mines and Geology, Report 26.
Federal Writers' Project of the WPA, Death Valley: A Guide (1939).
Gasch JW and Matthews RA, Geologic Guide to the Death Valley Area, California (1970) Annual Field trip guide book of the Geological Society of Sacramento.
Kirk R, Exploring Death Valley (1977).
Troxel BW and Wright LA, Death Valley Region field guide (1983).
Wallace WJ and Wallace E, Digging into Death Valley's history : three studies in historic archaeology (1981).

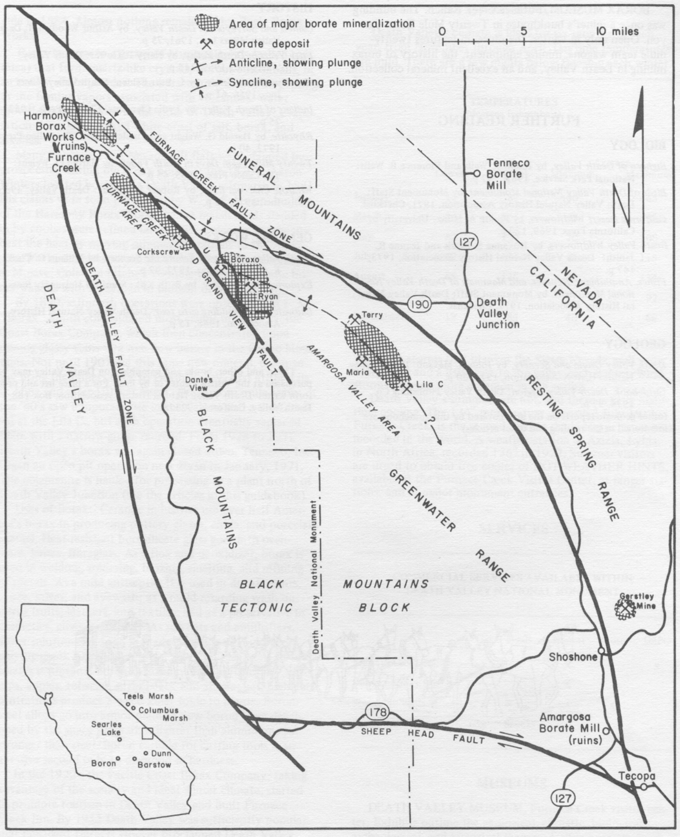
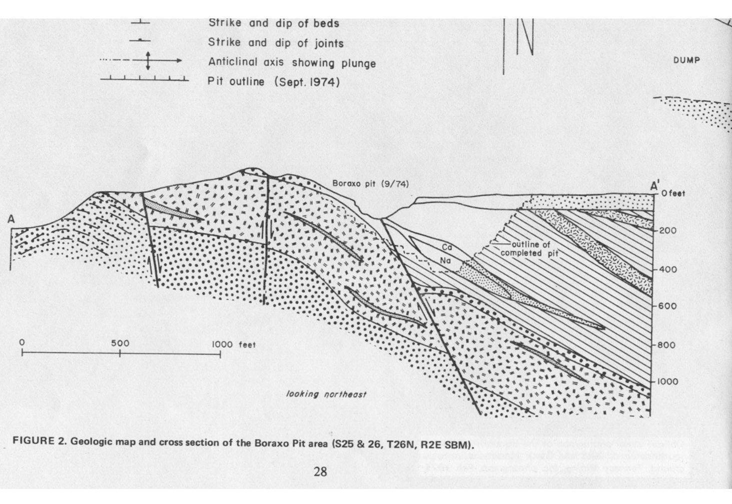


FIGURE 1. Map showing borate areas and structural features in the Death Valley area.



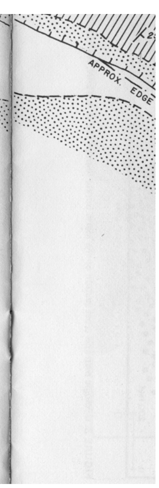


FIGURE 2. Geologic map and cross section of the Boraxo Pit area (S25 & 26, T26N, R2E SBM).

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Oblique aerial photograph of the Boraxo Pit, looking southwestward, with the Black Mountains in background. *Tenneco Mining, Inc. photograph, Feb. 1975.*