iron and titanium than mare soils, and perhaps lower than most highland soils. However, the specific compositional property causing the ultraviolet absorption in the red spot spectra is unknown. Correlations of red spots and KREEP (potassium, rare-earth elements, phosphorus) basalts have been suggested (*4*). However, preliminary analyses of laboratory spectra have not yet established any correlation with specific types of highland basalts (*9*).

Evidence from several sources demonstrates an Imbrian age for the domes. Stratigraphic relationships (Fig. 1a) show the domes to be superposed on the Imbrium basin and to postdate the formation of Iridum crater, of middle Imbrian age (*10*). Mare basalts mapped as Imbrian embay the Gruithuisen domes, and Eratosthenian mare (*10*) surrounds the Mairan domes. Techniques for dating crater morphology suggest an age of 3.1 × 10^9 to 3.3 × 10^9 years for the mare surrounding the two dome areas (*11*). On the basis of available evidence, the domes appear to have formed in middle Imbrian time, most likely between 3.3 × 10^9 and 3.6 × 10^9 years ago.

In conclusion, geologic and spectral reflectance evidence shows that a distinctive style of extrusive nonmare volcanism in northeastern Procellarum extended for perhaps 0.5 × 10^9 years into the period of mare volcanism. Several areas with similar spectral characteristics are known in the Oceanus Procellarum region and occur in a variety of geologic environments that may be synchronous with or predate the Mairan and Gruithuisen domes (*4*, *5*). Vidicon images and spectra for these regions have been obtained to document the characteristics, composition, and mode of emplacement of these distinctive geologic occurrences (*12*).

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6 October 1977; revised 9 January 1978

Salt Domes: Is There More Energy Available from Their Salt than from Their Oil?

Abstract. *Calculations indicate that a typical oil-bearing salt dome along the Gulf Coast of the United States contains more energy in its salt than is present in its oil. The magnitude of the potential salinity gradient energy is even greater when all of the salt domes are considered.*

At the interface between salt solutions of different concentrations, there is a potentially large source of usable energy. It is manifest mechanically in terms of the osmotic pressure difference between the two solutions. For the case of freshwater versus seawater, such as at a location where a river flows into the ocean, the osmotic pressure difference equals about 24 atm (*1*), equivalent to the pressure at the bottom of a column of water 240 m (750 feet) high. This height is comparable to the highest dams in existence. The energy inherent in this system is such that river water flowing at the rate of 1 m^3 per second theoretically represents more than 2 MW of power as it mixes with the sea.

The energy density is even higher where freshwater flows into a hypersaline lake such as the Dead Sea or the Great Salt Lake. The osmotic pressure difference is as high as 500 atm for the Dead Sea (*2*) (because of the large amount of the divalent salt $MgCl_2$ in the brines) and about 370 atm for the Great Salt Lake. In these cases the power can be greater than 30 MW for each cubic meter per second of fresh water flowing into the hypersaline lake.

There are other likely sources of salinity gradient energy. Along arid and semiarid coasts, dried lagoons or salt pans exist. Controlled influx of seawater will create concentrated brines that can be interfaced with seawater serving as the dilute solution. Subterranean brines and salt deposits can also be utilized as long as there is sufficient water, either fresh or brackish or marine, to form the dilute solution.

Several schemes have been suggested to harness salinity gradient energy (*3*, *4*). They range from mechanical conversion based on the use of the osmotic pressure difference or the vapor pressure difference of the two solutions, through electrical conversion by means of reverse electrodialysis, as in a dialytic battery. However, further research and development are necessary before any of these schemes can be actualized. All of the proposed methods will operate in principle between any two salt solutions with different concentrations.

Salt domes, subterranean formations

Table 1. Comparison of the energy available from the salt and the oil in selected salt domes (*7*).

Dome	Salt volume (cubic miles)	Oil production (10^3 barrels)	Salt energy (MW-years)	Oil energy (MW-years)
	High yield			
Thompson (Ft. Bend, Texas)	0.4	259,623	14,000	44,000
Hull (Liberty, Texas)	2.6	156,830	93,000	27,000
Humble (Harris, Texas)	9.8	138,639	350,000	24,000
	Medium yield			
Avery Island (Iberia, La.)	4.0	53,054	140,000	9,000
Bayou Blue (Iberville, La.)	4.6	20,806	161,000	3,500
Belle Isle (St. Mary, La.)	1.9	10,316	68,000	1,700
	Low yield			
Lake Hermitage (Plaquemines, La.)	0.9	2,475	32,000	420
Bethel (Anderson, Texas)	8.0	1,017	280,000	172
East Tyler (Smith, Texas)	4.3	55	150,000	9

of brine or solid salt, located adjacent to or under the sea afford a unique solution. The brine or salt dissolved from the domes could be pumped to the surface and interfaced with the seawater (or nearby groundwaters similarly pumped). Disposal of the end product would be no major problem, provided that it can be amply diluted in the sea and that it contains no petroleum remnants. If environmentally harmful substances are present, the final solution can be reinjected into the earth. Salt domes have been of interest because of their tendency to contain oil and gas deposits. Many salt domes have been monitored and drilled, particularly along the coastal zone of the Gulf of Mexico. These domes have been the source of some of the largest oil finds in the United States. Thus, it is surprising to consider that there may be greater amounts of energy available from the salt in the salt domes than is obtained from the oil and gas.

An extremely productive salt dome can yield 10^8 barrels of oil (1 barrel = 0.14 metric ton), but most domes yield less. Very few of the salt dome oil fields, such as Hastings West in Texas District 3 and Cailou Island in Louisiana South, are capable of producing as much as 6×10^8 barrels (*5*). If we consider that 1 barrel of oil is equivalent to 5×10^6 Btu's $\simeq 5 \times 10^9$ J = 170 W-years, a productive dome can yield 1.7×10^4 MW-years of energy. By comparison, the domestic demand in the United States for all petroleum products in late 1977 averaged 17.5×10^6 barrels per day (*6*), which would be about 10^6 MW-years for 1977.

A typical salt dome is about 1600 m in diameter and 1600 m in depth and has a volume of approximately 3.2×10^9 m^3 (0.75 cubic mile) of salt. The mass of salt in such a salt dome is about 7.1×10^{15} g if it is essentially pure NaCl, which is often the case. If other salts are present, they may be harmful to the membranes proposed for some of the conversion methods. Thus, they would have to be removed or other methods would be required. If the salt is dissolved in seawater until it has an osmotic pressure of 370 atm, 3.2×10^9 m^3 of salt would yield 2.8×10^4 MW-years of energy when diluted with seawater and recovered at 100 percent efficiency (*4*). Thus, even for a highly productive well, the salt is more energetic in theory than the oil. Table 1, which gives data for some actual examples (*7*), demonstrates even more clearly the partition of energy. We have listed the most productive wells, some average producers, and some below-average producers. There are many more oil wells in the below-average category than in the highly productive category.

Moreover, there are more "dry holes" than "strikes." Of the hundreds of salt domes that have been drilled, the majority contain no oil. Thus, the salt in salt domes is a large untapped source of energy even if it can only be converted at 5 percent efficiency. Research and development should improve our capability to capture this energy. Because of the present lack of information, it is not possible to estimate a likely efficiency but it could be higher than 25 percent.

Salinity gradient energy is a form of solar energy and is continuously renewed in the case of rivers flowing into the ocean or of inundated salt pans whose brine concentration is controlled by solar evaporation. The salt domes are examples of stored solar energy and are consequently nonrenewable on the short geological time scale. As is the case for oil and gas, once the salt in such domes is mined and utilized, it is gone for eons.

In addition to the salt domes, there are immense salt deposits in the Mississippi Valley and under the Great Plains, as well as in other places. If these deposits are near subterranean sources of brackish water, they also could be used to produce energy and the brine end product could be disposed of by reinjection into the earth.

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27 October 1977; revised 11 January 1978

Peyote Alkaloids: Identification in a Prehistoric Specimen of *Lophophora* from Coahuila, Mexico

Abstract. *Mescaline, anhalonine, lophophorine, pellotine, and anhalonidine have been identified in alkaloid extracts of a prehistoric specimen of* Lophophora *from a burial cave in west central Coahuila, Mexico. The specimen is associated with radiocarbon dates of A.D. 810 to 1070 and is one of the oldest materials ever submitted to alkaloid analysis.*

In 1941, Taylor conducted a brief but thorough salvage excavation in a small site, designated as CM-79, in west central Coahuila, Mexico (*1*). The site, a multiple interment burial cave, produced a variety of lithic and perishable artifacts ascribable to the so-called Mayran mortuary complex, which is centered in the Laguna District of southwest Coahuila (*2*). Site CM-79 is essentially a single component locality and is reasonably well dated by a series of three radiocarbon dates of A.D. 810 ± 70, 1020 ± 60, and 1070 ± 75 (*3*). These assays were performed on samples of plaited matting directly associated with the burials at this site.

Among the Mayran mortuary materials recovered from CM-79 were a number of peyote (*Lophophora williamsii*, Cactaceae) buttons strung on a cord and superficially resembling a necklace. One of these buttons was removed from the "necklace" and subjected to alkaloid analysis. The results of that analysis (*4*) follow.

The specimen chosen for the analysis (1.425 g) was ground to a fine powder in a mortar, mixed with ethanol to a slurry, stirred for 48 hours, and filtered. The ethanol extract was evaporated to dryness. The residue was dissolved in water, made alkaline with concentrated ammonia (*p*H 9), and extracted twice with chloroform and once with a mixture of chloroform and ethanol (3 : 1). The combined chloroform extracts were evaporated to dryness to yield 32 mg (2.25 percent) of alkaloids. These were resolved into phenolic (35 percent) and nonphenolic (65 percent) portions, as previously described (*5*).

Analytical thin-layer chromatography (TLC) was carried out on coated 0.25-mm silica gel F_{254} aluminum sheets in mixtures of chloroform, ethanol, and