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(The reader should remember that this information is based on notes recorded from verbal conversations with mine operators.)

Nevada, Lithium.--On June 25, 1974, I visited the Silver Peak Mining operation of Foote Minerals Co. whose head office is in Exton Pa. This lithium mining operation should really be referred to as the pumping and solar evaporation of lithium from subsurface brine.

The Silver Peak operation is located 24 miles west of Highway 95 by a gravel road and 20 miles on Highway 47, south of Highways 6 & 95, and about 50 miles southwest of Tonopah, in Esmeralda County, Nevada. Clayton Valley lies in Ts 1, 2 and 3 S R 39 & 40 E. The closed basin elevation is a little less then 4,300 feet. The small town of Silver Peak boasts 150 residents, and it can now be called a company town. All silver mining in the area ceased about 1956. Foote Minerals should take credit for reactivating a ghost town. Foote has supplied the residents with a drinkable liquid, the first in their history, other than wiskey and hot beer. Although the town at one time claimed to have 3,500 residents they must have been short-timers. The average summer temperature is about 90°. These high temperatures and little or no rainfall are essential for solar evaporation conditions.

Walter Cooke was general manager at Silver Peak, but I was informed that recently he had been transferred to North Carolina to run the Spodumene mines there.

Cliff Northrup has been designated the new General Manager, but it was not officially announced at the time of my visit, and he was not on the project. Mr. Ted Evans is general Superintendent or Assistant Manager. Ron Nelson is the Geologist and is in charge of brine production. Upon arrival, I was warmly welcomed by Evans and Nelson as well as by members of the staff, who turned out to be Ex-Vanadium Corporation of America employees from Naturita, Colorado. Some I knew during the uranium boom. The mailing address is Silver Peak, Nevada, and the office telephone number is 702-937-2222. Currently, 70 people are employed by Foote Minerals at Silver Peak.

Foote Minerals started on the Clayton Valley lithium brine project in 1964, when they drilled a test well and shipped barrels of brine back to Pennsylvania for testing. All the brine comes from land that is held as placer claims or as Federal leases. They have one mineral claim at the spring and another at the freshwater well. The drilling of wells, test pumping, construction of ponds, and evaporation concentration of lithium chloride started in 1965. They shipped their first $LiCO_3$ in 1966; and by 1968, they were in full production. In 1973 they produced 11½ million pounds (5,750 tons); and in 1974, they expect to produce at least 13 million pounds (6,500 tons). Currently their total production is lithium carbonate, about 70% powder and 30% pellets.

In 1968, they had about 30 wells 600 to 800 feet deep from which they were pumping brine. Now they are pumping from 45 wells. Since they started on this project, they have drilled about 100 wells. The present plan is to drill 12 more wells before the end of the year. Most of the wells are 600-700 feet deep. The deepest well was drilled at the southend

and it was 1,800 feet deep. They encountered nearly freshwater in this hole. Within ½ mile south of town, they drilled a shallow 300-foot well and obtained good fresh potable drinking water, flowing about 500 gallons per minute. This well supplies their mill and the town of Silver Peak at no charge to the local residents.

Clayton Basin is about 8 miles long and 4 miles wide. Foote Minerals has 14 ponds covering about 5,000 acres under solar evaporation. In building this operation, they have built many miles of roads, dikes, and power lines which always need maintenance. Ron Nelson arrived on this project in 1967. He has been in charge of the drilling, pumping, and evaporation. Sometimes they are forced to abandon a well because it silts-up or the flow rate drops below a designated minimum. In the central part of the basin, the ground has dropped about one foot so now they are pumping from the north and southends to keep the basin floor level. The construction and maintenance of the ponds and the transfer of the brine from pond to pond is tricky and requires vigilance.

The fresh brine contains about 2,500 ppm of LiCl and various amounts of magnesium and calcium and a much higher percentage of potassium and sodium. Only traces of uranium and fluorine have been reported in the many-many assays made. The calcium, sodium, and potassium salts precipitate readily in the solar ponds; but the magnesium is more difficult to separate. Both the magnesium and calcium are deletrious to their mill circuit and are eliminated as much as possible in open ponds. The brine ponds are normally less than one foot deep. They prefer to keep the brine 6 to 12 inches deep for maximum heating and evaporation by the sun. By pumping the brine through 5 or 6 ponds, they increase the concentration from 2,500 to about 4,000 ppm of LiCl with a ph of 8 to 9.

Most of the sodium, potassium and calcium salts are precipitated by solar evaporation; but to eliminate the magnesium, they go through a special step. In the middle of the playa, they have 1 large metal tank and 2 smaller tanks. Freshwater and lime (CaO) are mixed in the 2 smaller tanks, and then the CaOH solution overflows into the larger tank, 30 feet in diameter, where it is mixed with a brine concentrate, ph 8, containing about 4,000 ppm LiCl. The mixture forms a solution of LiMgOH. This mixture has a very high ph, 12-14. The MgOH starts to precipitate in the tank; but the volume is large, and this milky liquid pours out of a trough from the top of the tank and into the first of 6 large settling ponds. More MgOH settles out in each pond until the ph is down to about 9 and only NaCl is precipitating. This concentrated solution containing about 5,000 ppm LiCl or better is pumped into the R 2 pond, which is their main storage pond. This R 2 pond is a specially built artificial lake of blue-green color. The bottom is covered with asphalt and then sprayed with a (PVC) plastic coating to prevent leakage. The current pond contains 19 million gallons assaying about 6,800 ppm LiCl. This concentration is higher than they prefer. They normally try to keep the concentration at 6,000 to 6,500 ppm, because at 7,000 ppm, LiCl starts to precipitate.

From the R 2 pond the liquid is pumped to the mill, where it goes through a series of 6 large tanks to eliminate nearly all of the calcium, magnesium and foreign particulates. The plant operates between 110 to 150 gallons per minute. This is the limit of their filter presses. They could process a larger volume, and double their output by doubling their filter press

capacity. From the filters the fine green silt is taken to the 3 reactor tanks or boilers where soda ash is added and heated. The lithium combines with the carbonate to form lithium carbonate. When the material leaves the 3d reactor it is a fine white crystalline sand. This sand passes through another filter and then through a rotary kiln dryer, heated by butane gas, and is reduced to a fine white powder containing less than ½% water. This is the major product that is sold to the chemical industry.

They also make a lithium carbonate pellet from the powder. They add 1 to 2% starch and up to 15% H_2O and pass it through a pelletizing machine, subjecting the material to pressure and heat. The pellets are then dried, barrelled and shipped to aluminum reduction plants. About 1/3 of their product is pellets. They could sell more if they could produce more.

The plant super said they could increase their output by increasing their filter capacity, but that would not help because they cannot buy enough soda ash to satisfy their current production. So again soda ash is the bottleneck limiting production.

They are currently producing between 1.1 and 1.2 million pounds per month of lithium carbonate. About 71% of the lithium is extracted from the solution. The diluted solution containing about 700 ppm LiCl is pumped back into the R 2 pond for re-circulating. Very little lithium is lost at the plant or by leakage at the ponds.

Currently, Foote Minerals is working on a pilot plant to use the diluted solution that they return to the R 2 pond. They are combining aqueous HF or NHF with the LiCl, to make LiF. They are experimenting with HF purchased from the Allied Chemical Plant at Pittsburgh, Calif. Before the start of 1975 they hope to be producing LiF for the aluminum industry to use in their alumina melt.

The source of the lithium is lithium brine that is pumped from volcanic ash beds that were deposited in this basin. Volcanic cones, built of ash and lava occur on the N & E side of the basin. The lithium apparently has been dissolved from the volcanic ash material. The volcanic beds are known to total 2,500 feet thick. Most of the brine comes from a few tufaceous aquifers that range from 3 to 5 feet thick, but one aquifer is 20 feet thick. They have lost some wells by the fine ash sanding up the bottom and cutting off the flow. The wells are located about 1,000 feet apart so the draw down from one well will not effect the other well. In the central part of the basin the withdrawal of brine from these ash beds 600-700 feet deep has caused the basin surface to settle about one foot. When this settling occurs they have to build up their roads and pond levees. Apparently, there is some structural failure of the weak ash beds, as well as some compaction due to withdrawal of the liquid brine.

Ron Nelson would not make an estimate of the lithium reserve in the brine, because he could not determine the volume of liquid brine in the unmeasured aquifers. However, he did say that at their present rate of consumption, they had at least 30 years supply. In the future they may be able to concentrate economically brine solution containing only 1,000 ppm LiCl., thereby, increasing the life of Clayton Basin.