Subject: Sulfur deposits in Nevada Date: November 2, 1966

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Introduction

As you requested I have visited the principal areas where sulfur occurs in Nevada. The following description tells of the current status of these deposits, their geology, and their probable economic potential. I have included in the introductory portion some information on the reasons for the current interest in sulfur.

Interest in sulfur deposits in Nevada probably is at an all-time high. This is a reflection of the current free world supply and demand situation. For three years demand has exceeded production and excess orders have been filled from stockpiles (private stockpiles; sulfur is not a government stockpile commodity). Demand for sulfur continues to grow at a rate of 6 to 7 percent a year. In 1965 free world production of all forms was 22,800,000 long tons. Recent estimates are for a consumption in excess of 30,000,000 long tons in 1970.

The fertilizer industry is the largest consumer. In 1965 the domestic phosphate industry used 6,700,000 long tons in the acidulation of phosphate rock with sulfuric acid. The most promising substitution in this industry is by nitric acid but this gives a more expensive and less suitable product. Sulfuric acid will probably be used as long as supply and price permit.

Sulfur to meet this demand will have to come mostly from reactivated and new Frash process installations along the Gulf of Mexico. The limitation of exports from Mexico to a percentage of newly-found reserves further complicates the situation. There will be increased yield from sour gas fields but the additional tonnage will be relatively small. Sulfur produced from deposits of the type found in Nevada and California will never be an important factor in supply. It is obvious that there will be abnormal interest in sulfur deposits until 1970 at least.

The shortage has caused a price increase but the amount is uncertain because quotations commonly give only nominal figures. Domestic bright sulfur has been quoted at $27 since 1964. In September of 1966 the E. and M. J. Metal Market, while still retaining this quotation, also quoted $39 f.o.b. Gulf ports for export and stated that the current spot market is about $42 f.o.b. mine.

Nevada Sulfur Deposits

The following is a summary of Nevada sulfur deposits, in north-to-south order of location.

1) Sulphur district, Humboldt County. This district is along the northwest edge of the Kamma Mountains, principally in Sections 35 and 36, T. 35 N., R. 29 E. The Western Pacific railroad goes through the settlement of Sulphur several miles northwest of the area. The patented claims that cover this area are optioned to Canyon State Mining Company and/or Pacific Sulphur Company. One or both of these companies is a subsidiary of Great American Industries, a New York based firm.

The main part of the district has an exposed length of about 6,500 feet and an average width of about 1,800 feet, with a north-northeast trend. This is expressed topographically, with the sulfur district situated on an irregular, hilly terrace. This terrace is bounded on the west by a bluff that extends down to the valley floor, and is bounded on the east by another bluff that leads to the higher mountains farther east. There is evidence that the bluffs actually are fault scarps.

The rocks exposed on this terrace are water-lain sediments of Tertiary age. The predominant rock is a well-cemented conglomerate but some sandstones probably are present in the southwestern part. Generally the rocks dip eastward at low angles. The bluffs are composed of resistant, partly opalized and silicified conglomerates. Alteration within the confines of the terrace is variable. Most of the area is underlain by a light-colored - or locally red stained - friable, siliceous material; in the strongest altered places an occasional unaltered pebble is the only evidence of the original character of the rock.

Sulfur has been mined from about a dozen pits. These range in size from one about 250 by 150 feet (the Mercury pit) to some less than 50 feet in diameter. Outside the pit areas there is only occasionally any evidence of sulfur mineralization. Structural control of the mineralization is not apparent although north-northeasterly trending faults or fissures may have exercised some influence.

The sulfur occurs as disseminated grains, preferential replacement of the conglomerate matrix, irregular veins and masses and coatings on fracture surfaces. The average grade of material mined in the past is said to have been 15 to 38 percent. The most abundant accompanying materials are silica minerals, alunite and some gypsum. Mercury is present in some of the material; conceivably it could be a by-product. Some silver mineralization is present along the western bluff at the south end but there is no sulfur in this area.

There are several other sulfur occurrences outside the area discussed above. The most important of these is the Peterson pit area about one mile to the northeast but still within the claim group. Sulfur occurs as fairly high-grade material along a north-northeast fault zone (parallel to the faults mentioned above) that brings conglomerate on the west down against older volcanic rocks. This area and the Mercury pit have the best sulfur reserves seen on the property.

Drilling was started this April. It was stopped early in October but apparently is to start again. I estimate that 150 rotary holes have been drilled; these are irregularly spaced throughout the altered area but have a denser distribution in the old pit areas. The maximum depth observed was 300 feet but the average depth was less than 100 feet. Examination of the cutting piles from many holes showed a surprising lack of sulfur in much of the area. With few exceptions only holes in or close to the old pits seemed to have encountered much sulfur and then generally only in the upper part of the holes.

Evaluation of the potential of this district is difficult without a detailed analysis of drill hole results. Almost certainly this district will never be a major source of sulfur, particularly if one is referring to pure, bright sulfur. However, in view of the area size and the number of pits it

is not impossible that several million tons with grade in the order of 30 percent might be developed. Certainly this district has the best sulfur potential of any in Nevada.

2) Humboldt, Pershing County. This area is one mile southwest of Humboldt House and 500 feet west of the Southern Pacific tracks. It is on a hill about 800 by 500 feet rising about 30 feet above the surrounding plain. Exploratory work and evidence of sulfur is restricted to a central portion about 200 feet in diameter.

Much of the area is underlain by calcareous tufa; most of this is porous, friable, horizontally bonded material. Crystalline gypsum occurs as interlayers within the tufa and as a small, vertical mass at the center. The bright sulfur generally is associated with the gypsum. Probably the maximum grade of native sulfur is about 25 percent; the gypsum as a whole contains less than 10 percent native sulfur. This obviously is a hot spring deposit.

Exploration and mining was by a number of irregular pits and several shallow shafts. Production from the area was small. An inclined shaft about 30 feet deep was in tufa with little or no sulfur. A pipeline excavation along the east side of the hill penetrated barren tufa for 800 feet. There has been no activity at the property in recent years. I do not believe that this area is capable of producing any significant amount of sulfur.

3) Hot Springs Point, Eureka County. This area is at the extreme western end of Dry Hills, in Sections 11 and 12, T. 29 N., R. 48 E. This is about 13 miles by road south of the railroad at Beowawe. The property is covered by unpatented mining claims. These are controlled and are being explored by the Southwestern Exploration Company, which is stated to be a joint venture of Hunt Oil Company, Nationwide Oil Company and the Hathaway family. The work is being directed by Mr. Ralph Edwards of Reno.

The end of the mountain is bounded by two intersecting faults that separate the steep mountain slopes from a nearly flat, alluvium-covered valley. A north-northeasterly trending fault bounds the northwestern side of the range for some distance while a northwesterly trending fault bounds the southwestern side.

Sulfur is now exposed in a face up to 50 feet high for a distance of 300 feet. The sulfur appears to be restricted to the northwest-trending fault zone; this zone is about 50 feet wide and has a nearly vertical dip. Shales and quartzites, regarded as Ordovician in age, are present on the northwest side; these rocks are strongly silicified adjacent to the structure. A trench on the valley side of the fault zone is in unconsolidated gravel.

The rocks within the zone are strongly altered to a clayey material; native sulfur is irregularly distributed through this material. A small tonnage of fairly high-grade material has been sorted out; mining of the entire zone, as now exposed, would yield a very low grade material. Small amounts of cinnabar and antimony are reported to be present in the material.

The north-northwest fault has been explored by trenches over a length of about one-fourth mile. There has been some bleaching and alteration along this structure but sulfur was not found. There are a number of almost inactive hot springs near the Point.

My examination suggested that development of additional sulfur must be to the southeast along the mineralized fault zone. Mr. Edwards is of the opinion that the sulfur-bearing material extends for some distance back into the mountain. He had a crew of three men ineffectually drilling short holes into the silicified rocks on the northeast side. He planned to start core drilling in the same area.

It seems extremely unlikely to me that an adequate tonnage can be developed to support a mill to upgrade this material. Even if a considerable strike length of ore can be developed, mining below a shallow depth would have to be by underground methods. It is more reasonable to expect that any production from this area will be sulfur for agricultural use in limited tonnages.

4) San Emidio, Washoe County. This area is on the west flank of the Lake Range near its north end, mostly in the central part of T. 29 N., R. 23 E. The zone is covered by patented placer claims.

An altered zone is intermittently exposed for a distance of more than 7,000 feet in a north-south direction. This is on an alluvium-covered slope some distance west of the linear front of the mountains. Pleistocene sediments and Lake Lahontan beds are exposed in a number of trenches, cuts and pits. The former range from sandstone to fine conglomerate; they are altered in all exposures. The Lake Lahontan sediments vary from silts to occasional conglomerates; they are flat-lying and overlie the altered rocks.

Sulfur is poorly exposed in a few places. It occurs as disseminated particles and irregular masses in a dark gray clay, siliceous sinter or opal. Crystalline gypsum is very common, generally as a one-foot or thicker layer on top of all altered material. In some places it overlies the sulfur with a fairly sharp contact between the two minerals. Cinnabar is rather common in the altered material. The width of the zone has never been determined. The zone probably reflects a structurally aligned group of hot springs. Warm ground in a few places shows that some of these are still partly active.

Signs near the property state that the property is controlled by Base Minerals, Inc., 512 Las Vegas Blvd. So., Las Vegas. There was no activity at the time of my visit but this company had drilled two very shallow holes.

It is unlikely that sufficient sulfur could be found in this area to be of commercial interest. However, the cinnabar mineralization may deserve more exploration and sulfur possibly might be recovered as a by-product.

5) Alum, Esmeralda County. This area is located in the western part of the Weepah Hills, about eleven miles north-northwest of Silver Peak. The township is unsurveyed but the property probably is in Section 29, T. 1 N., R. 39 E. The property is covered by patented lode claims held by Nevada Potash and Chemical Company.

The district lies at the west edge of a group of hills made up of Tertiary rocks, principally pyroclastic, that dip eastward at moderate angles. To the west are scattered outcrops of Tertiary sandstones and bentonitic rocks.

The main mineralized area is the site of an open pit about 200 feet in diameter. The pit has a maximum depth of about 40 feet on its east side. Many of the geologic features are obscured by dumps and broken rock. Most of the pit seems to be in a white pulverulent material consisting mostly of alum minerals and quartz, with variable sulfur and some gypsum. Partly altered volcanic rocks are exposed on the northeast, east and southeast sides of the pit; these dip eastward at 30 degrees or steeper. The contact between the volcanic rocks and the completely altered material is not well exposed but it appears to be fairly sharp. Vertical and inclined shafts surrounding the pit area indicate that the alum-sulfur body is restricted to a surface diameter about the size of the pit. A pipe-like, steeply inclined body cutting across layering of the host rock might be postulated. The sulfur occurs as relatively thin coatings on fractures and impregnating the rock. There is no high-grade material; the ore might average 20 percent native sulfur with selective mining.

About 500 feet to the northeast there is a much smaller but somewhat similar body that contains only a little sulfur. There are several very small areas of altered rocks farther north.

There were a number of idle pieces of equipment at the property but very little work had been done. The one man I found on the property professed ignorance about who he was working for. A considerable amount of promotional activity that I observed in the Esmeralda County courthouse could be concerned with this area.

The deposit might be a source of sulfur for agricultural use. In view of the apparent size of the outcrop area, it is doubtful that it could support a mill for processing the ore.

6) Tognoni Springs, Nye County. This property is on a ridge in the W 1/2 of NE 1/4 of Section 27, T. 2 S., R. 43 E., about one mile east of Tognoni Springs. Lode claims dated July, 1966 cover the area; I did not see any recent location work.

An old excavation about 15 feet long and up to 10 feet deep exposes sulfur in a zone of alteration 6 to 8 feet wide. Outcrops of unaltered andesite breccia appear to limit the possible strike length to 75 feet. Sulfur occurs as occasional masses in an otherwise barren zone. It replaces the matrix of the altered rock and also occurs as vuggy incrustations. About one ton has been hand sorted to an estimated grade of 50 percent. There are several other shallower cuts and one short adit in similar altered material but with no sulfur. The possibility of producing any significant tonnage from this property are slight.

7) Deep Gulch, Esmeralda County. This property is in Section 36, T. 4 S., R. 42 E., 12 miles south of Goldfield and 1 mile west of U. S. Highway 95. There was no activity at the property but it was relocated by a group of claims dated in May of 1966.

The sulfur occurs near the top of a prominent hill. Although outcrops are often poor, the entire hill over an east-west distance of about 800 to 1,000 feet appears to be made up of an altered breccia that contains some recognizable fragments of a fine-grained volcanic rock. There are some areas of intensely bleached and altered rocks and others where coarse, sinterous silica is abundant. At the very top of the hill - and overlying some of the sulfur - is a flat-lying, strongly silicified capping. The main bulk of the material, however, is a loose, unconsolidated breccia. Part of this, at least, is crudely banded with a nearly horizontal attitude. The origin of the breccia is uncertain.

Most of the breccia contains no sulfur. There is some suggestion that the sulfur concentrations are along two north-south zones; there is practically no sulfur left in place so its original distribution is hard to determine. A west zone has been prospected or mined over a length of about 200 feet and a width of about 20 feet. A possible second zone about 100 feet to the east is less distinct. It is suggested by a short adit at the south end and an open cut and underground workings at the north end. Both of these mined areas are beneath the silicified capping; this fact plus the occurrence of several horizontal bands of sulfur suggest deposition beneath an impervious capping. The sulfur commonly replaces the matrix of the breccia and some is in fairly massive form. A small stockpile suggests that some relatively high-grade ore was shipped - perhaps 50 percent.

As in most of the other deposits, the possibility of finding an adequate tonnage to support a mill is quite small. A favorable factor here, however, is the relatively large area underlain by breccia as a potential host. It is likely that most recovery would have to be by underground methods in soft and ravelly ground.

8) Cuprite, Esmeralda County. This property is in an unsurveyed area, in Section 5, T. 5 S., R. 43 E. This is 13 miles south of Goldfield and 1 mile east of Highway 95. The area is located by a lode and placer claim of Argentum Consolidated Mines, Inc.

The country rock is a light-colored, felsitic volcanic rock; at least part of this is the bleached equivalent of more highly colored rocks. There are a number of underground workings in an area powdery, oilliceous altered material. The most intense alteration is an area perhaps 100 feet across. While no sulfur was seen in place, several hundred pounds were piled on one of the adit dumps. This material might average 30 to 40 percent.

This property does not seem to be very promising for any tonnage of ore. The Cuprite - Deep Gulch area might be a favorable place, however, for regional exploration for sulfur.

Conclusion

Examination of Nevada sulfur deposits as a group has led to some conclusions.

1) There is no present production of sulfur and the possibility of finding large tonnages amenable to production of pure sulfur are poor.

2) Directly mined, high-grade ore - say over 70 percent - could be available in only small tonnages.

3) There is a better possibility of producing limited tonnages of sulfur rock for agricultural use. In relation to percentage of total sulfur, it might be advantageous from a price standpoint to produce agricultural sulfur.

4) Based on the evidence now available, I rate the properties in the following order of potential economic significance: a) Sulphur; b) Alum; c) Deep Gulch; d) Hot Springs Point; e) San Emidio; f) Tognoni; g) Humboldt; and h) Cuprite.

5) By-product material might enhance the value of some ores. This is particularly true of mercury. Cinnabar is known to be present in significant quantities at the Sulphur and San Emidio properties.

6) Transportation must be considered in property evaluation. The Sulphur, Hot Springs Point and Humboldt areas are well situated near railroads, but the others are poorly situated at distances of 45 miles or more from railroads. Soil conditioner, mainly for a central California market, might not be dependant upon railroad location; it might be better transported by truck.