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Introduction

Potash resources in the Paradox basin of southeast Utah and southwest Colorado are large and occur in a complex geologic setting. In terms of their economic development, these resources fall into three categories: (1) deposits that are at depths suitable for conventional shaft mining and are not complexly deformed; (2) deposits that are complexly deformed and are at depths ranging from a few hundred to thousands of feet; and (3) deposits that are relatively flat lying and undeformed, but are too deep to be exploited except by solution mining. This report is a description of one deposit that falls into the last category and is considered to be an attractive target for solution mining.

The potash deposits of the Paradox basin are in the Paradox Member of the Hermosa Formation of Middle Pennsylvanian age. In the Paradox basin proper, the Paradox Member consists of at least 29 evaporite cycles, each of which contains a halite bed (Hite, 1960). Eighteen of these cycles also contain potash deposits (Hite, 1961). Normally, the greatest concentration of potash in any of these cycles is in the deep northeast flank of the basin One exception is evaporite cycle 13, which contains a potentially economic deposit of potash along the shallow northwest edge of the basin. This deposit, which appears very favorable for development by solution mining, is the subject of this report.

Location

Potash is present in cycle 13 over a large part of the Paradox basin (Hite and Liming, 1972); however, the greatest development of thickness and grade (percent K_2O) appears to be along the northwest side of the basin. This area of favorable development is located about 30 miles (48 km) north of the confluence of the Green and Colorado rivers (fig. 1). It is about

20 miles (32 km) northeast of Moab and about 16 miles (26 km) due south of the town of Green River. The Green River flows across the area, and its steep-walled canyon, which locally is as much as 1,000 feet (305 m) deep, divides the area in two parts. Most of the region is a relatively flat plateau, except where the Green River and tributary canyons have cut deeply into bedrock. Access to the eastern half of the area is most easily made by paved road, which begins at Sevenmile Canyon about 10 miles (16 km) north of Moab on Highway 160. This road, which extends south to Dead Horse Point State Park and the Canyonlands National Park, reaches within about 6 miles (10 km) of the eastern boundary of the potash area. From that point on, the area can be reached by unimproved roads and jeep trails. The western third is somewhat isolated by the deep and unfordable canyon of the Green River, and the only means of access is by dirt road extending south from the town of Green River. The Denver and Rio Grande Western Railroad spur, which extends south from the mainline at Thompson, Utah, to the Texas Gulf, Inc., potash mine at Cane Creek, passes within about 10 miles (16 km) of the eastern boundary of the potash area. Although the Green River creates a problem of accessibility to the western third of the potash area, it would provide an important source of water for solution-mining operations. The climate also favors the use of solar energy for concentrating potash brines. Average precipitation is probably less than 10 inches (254 mm). The land surface is used only to a limited extent for grazing purposes, and no national or state parks are closer than 15 miles (24 km) from the area boundary. Much of the land surface is flat and probably suitable for construction of evaporation ponds. The soil cover is thin, however, and bedrock consists of permeable sandstone; thus some artificial seal would be necessary in any brine pond.

Evaporite-cycle-13 potash

In the area of good potash development in cycle 13, the total thickness of halite-bearing rocks in the Paradox Member reaches a maximum of about 3,600 feet (1,100 m). The top of the salt is represented by the halite of evaporite cycle 2. Cycle 13 is at about the middle of the total halite-bearing sequence. The potash deposit in cycle 13 is in the upper part of a halite bed that ranges in thickness in the report area from zero to 240 feet (73.2 m). The isopach map of the halite in this cycle (fig. 2) shows a depositional thickening centered in T. 24 S., R. 16 and 17 E. This anomaly is probably due to depositional thickening in a local structural depression during Paradox time. This depression also influenced deposition of potash, because the greatest accumulation of potash salts (fig. 3) closely corresponds with the halite isopach. The potash-bearing interval reaches a thickness of about 100 feet (32.8 m) in the McRae Federal No. 1 well in sec. 10, T. 25 S., R. 18 E., which is the maximum known thickness for the area. The potash interval contains several barren or low-grade units, and these were subtracted from the aggregate thickness of potash shown on figure 3. Thus, the aggregate potash thickness in the previously mentioned well is about 75 feet (22.9 m). The potash deposit has not been cored in the report area; and, therefore, the mineralogy of the deposit is based entirely on the interpretation of geophysical logs. In most wells intersecting this deposit, the dominant potash mineral appears to be sylvite (KCl); however, in several wells, carnallite ($KCl \cdot MgCl_2 \cdot 6H_2O$) may also be present. (See the McRae well, fig. 4.) The interpretation of the presence of carnallite is based on neutron logs that show the presence of H_2O (bound water). However, potash deposits are very soluble, much more so than halite; and frequently the drill hole may be enlarged by solution through the deposit. The resulting out-of-gauge hole can give a log response similar to that of pore water or bound water. Therefore, although carnallite seems to be present in several wells intersecting this deposit, the neutron response might also be due to dissolution of potash.

Structure in the report area appears to be rather simple, consisting primarily of a gentle regional dip of about 120 feet (22.7 m per km) into the deeper part of the Paradox basin (fig. 5). The exception to this is along the southwest limit of the potash deposit, where the dip is much steeper. Relief between the Shell Oil Co.'s Gruvers Mesa no. 1 (sec. 19, T. 24 S., R. 16 E.) and Gruvers Mesa no. 2 (sec. 10, T. 25 S., R. 16 E.) is about 920 feet (280.5 m) in a horizontal distance of about 5 miles (8 km), suggesting the presence of a northwest-trending fault between the two wells.

Correlation between all wells in this area is very good, and there is no evidence of the complex folding and faulting which is common in many of the salt anticlines of the region.

The "Yellow Cat" lineament (Hite, 1975) cuts diagonally across T. 25 S., R. 18 E., and appears to have a pronounced effect on salt thickness (fig. 2). This lineament, which trends northeast across the Paradox basin, is probably related to basement wrench faulting, whose primary movement is left-lateral strike slip. Intense fracturing of the evaporites along this shear may have caused salt solution by introduction of meteoric water. Elevation of the ground surface throughout the potash area ranges from about 4,000 to 5,000 feet (1,220-1,524 m). Accordingly, depths to the top of the potash deposit will range from 5,000 to 6,500 feet (1,524-1,982 m).

SUMMARY

The potash in cycle 13 offers an attractive potential as a solution-mining target. Exploration of this deposit should be guided by the halite isopach of this cycle. Cumulative thicknesses of potash within the mineralized interval will probably exceed 50 feet (15.2 m) throughout the area within the 200-foot contour, an area of about 100 square miles (259 km^2). Potential resources of potash in this area are quite large. Using an average thickness of 60 feet (18.3 m), there may be 4.74 billion metric tons of potash ore in place. Assuming an average grade of 15 percent K_2O--and from geophysical log interpretation this would appear to be a conservative figure--the K_2O equivalent would equal 711 million metric tons. Well control is as yet too sparse to establish what the maximum thickness of the potash deposit might be. However, the configuration of the halite isopach suggests that it might easily reach 100 feet (30.5 m) near the center of the area within the 200-foot contour. The potash deposit is essentially flat and at depths well within the range of present-day solution-mining techniques. One foreseeable problem may be the presence of the mineral carnallite. This mineral contains less potash than sylvite (16.9 percent versus 63 percent K_2O). In addition, the magnesium chloride in carnallite complicates the phase-rule chemistry of the solution-mining brines, and as a byproduct of solution mining may also create a problem of disposal. Other factors favoring development of this deposit include availability of a water supply, the relative nearness to a railroad, favorable climatic conditions for evaporation ponds, and lack of other interfering surface use.

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