Geology of the I.M.C. Potash Deposit Esterhazy, Saskatchewan

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ABSTRACT

International Minerals & Chemical Corp. (Canada) Ltd. is presently exploiting a potash-rich ne in the middle Devonian Prairie Evaporite Formation by underground mining near Esterhazy, tskatchewan. Of the three main potash-bearing horizons denoted by Goudie as zones 1, 2, and only the lower two are present at Esterhazy and mining is confined to the lower or zone 1 hori- m. The area in which the evaporites were deposited, although flanked on the west by a zone of eosynclinal deposition and tectonic activity, has been subject to only very gently epeirogenic ctivity. The sylvinite ore is coarsely crystalline and occurs in well-defined beds. The halite, ylvite and insoluble content of the ore bears a direct relationship to the lithological units, but the arnallite cuts across the beds. Local concentrations of salt produce blank spots in the ore hori- on. Some of these appear to be salt-filled, post-ore channels and cracks while others have been ormed by brines emanating upward from below the ore. A number of observed phenomena suggest hat the present mineral assemblage does not represent the original primary minerals of the leposit.

INTRODUCTION

The potash mining operation of I. M. C. (Canada) is located near Esterhazy, Saskatchewan, on the Canadian Prairies (Fig. 1). It is situated towards the southeasterly end of the "potash belt." The mining depth is approximately 3,000 feet.

The I. M. C. deposit was discovered in 1955. Subsequent drilling outlined extensive high grade reserves and a shaft was begun in 1957. Production commenced in September, 1962, and the initial capacity of one million tons of muriate of potash per year was quickly reached. Production is currently being expanded to give a milling capacity of two million tons per year.

GENERAL GEOLOGY

The Esterhazy area is situated on the northeastern rim of the Williston basin and the formations dip to the southwest at an overall rate of 40 feet per mile. As a section through I. M. C.'s Yarbo Shaft shows, (Fig. 2), the middle Devonian Prairie Evaporite Formation, which contains the potash beds, is overlain by 1,500 feet of Palaeozoic limestone, dolomite, and anhydrite, which in turn is overlain unconformably by 200 feet of poorly consolidated Jurassic and Cretaceous sandstone and 1,000 feet of Cretaceous shales.

There has been extremely little tectonic disturbance of the evaporites at Esterhazy. The resultant structural stability of the ore body contributes much to its value.

Of the three main potash-bearing horizons denoted by Goudie as zones 1, 2, and 3, only zones 1 and 2 are present at Esterhazy (Fig. 3). The uppermost bed, zone 3, appears to have been

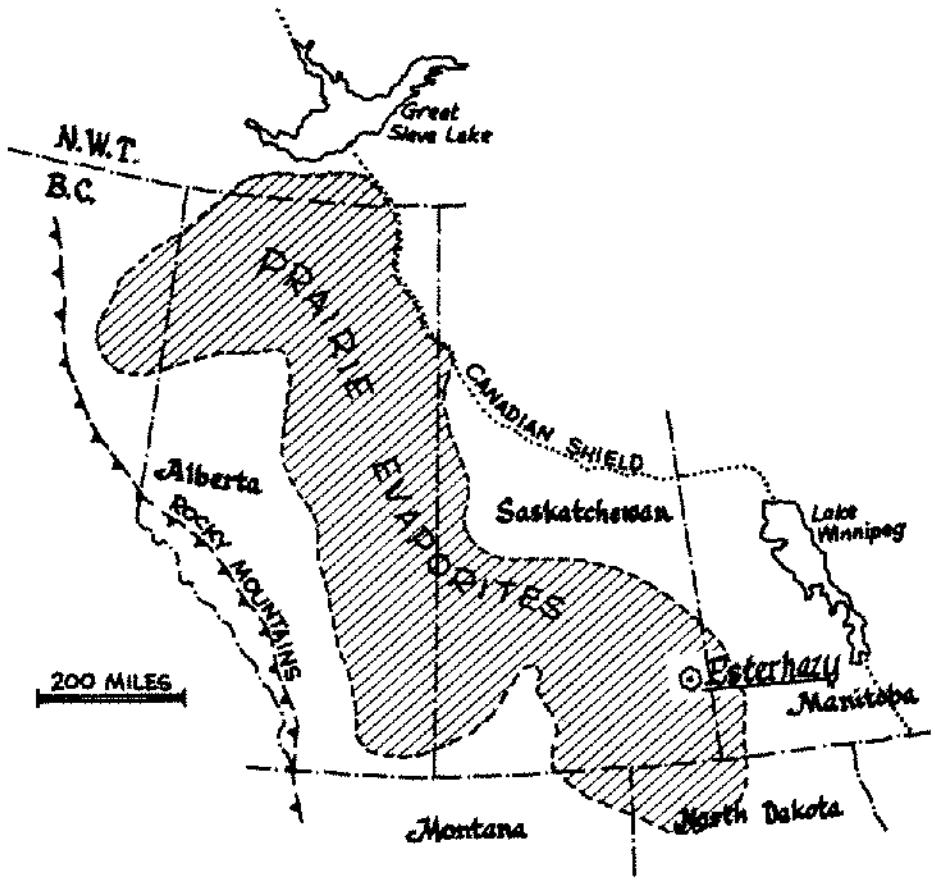

Figure 1. Location Map -- IMC (Canada).

removed by erosion. I.M.C. is mining only the lower part of zone 1. The upper portion of zone 1 does not carry commercial potash values at Esterhazy. The bottom 8 1/2 feet combines excellent grade with low insoluble content. The 100-foot cushion of salts between the mining horizon and the shales of the Second Red Beds greatly increases the safety of the mine against subsidence-induced fracturing of the upper formations. Mining extraction is being held to a conservative figure while the behaviour of the salt formation under the stress of mining is studied.

Zone 2, at the top of the evaporites, has not been seriously considered for mining because of inadequate salt cover.

MINE GEOLOGY

The Ore Beds

The ore mined at Esterhazy is sylvinite, a mechanical mixture of halite and sylvite, containing some insoluble material and a limited amount of carnallite in some areas.

In low-carnallite ore, milky halite crystals occur in a ground mass of clear, waxy sylvite. Usually the sylvite crystals have thin reddish reaction rims. These rims are absent in ore containing carnallite, which takes on the red coloration. Carnallite, where present, fills interstices between halite and sylvite crystals and also fills fractures in the halite and sylvite. The interstitial insoluble material consists of finely-divided dolomite, anhydrite, and clay.

The ore horizon comprises several distinct beds. For ease in identification, they have been assigned numbers (Fig. 4).

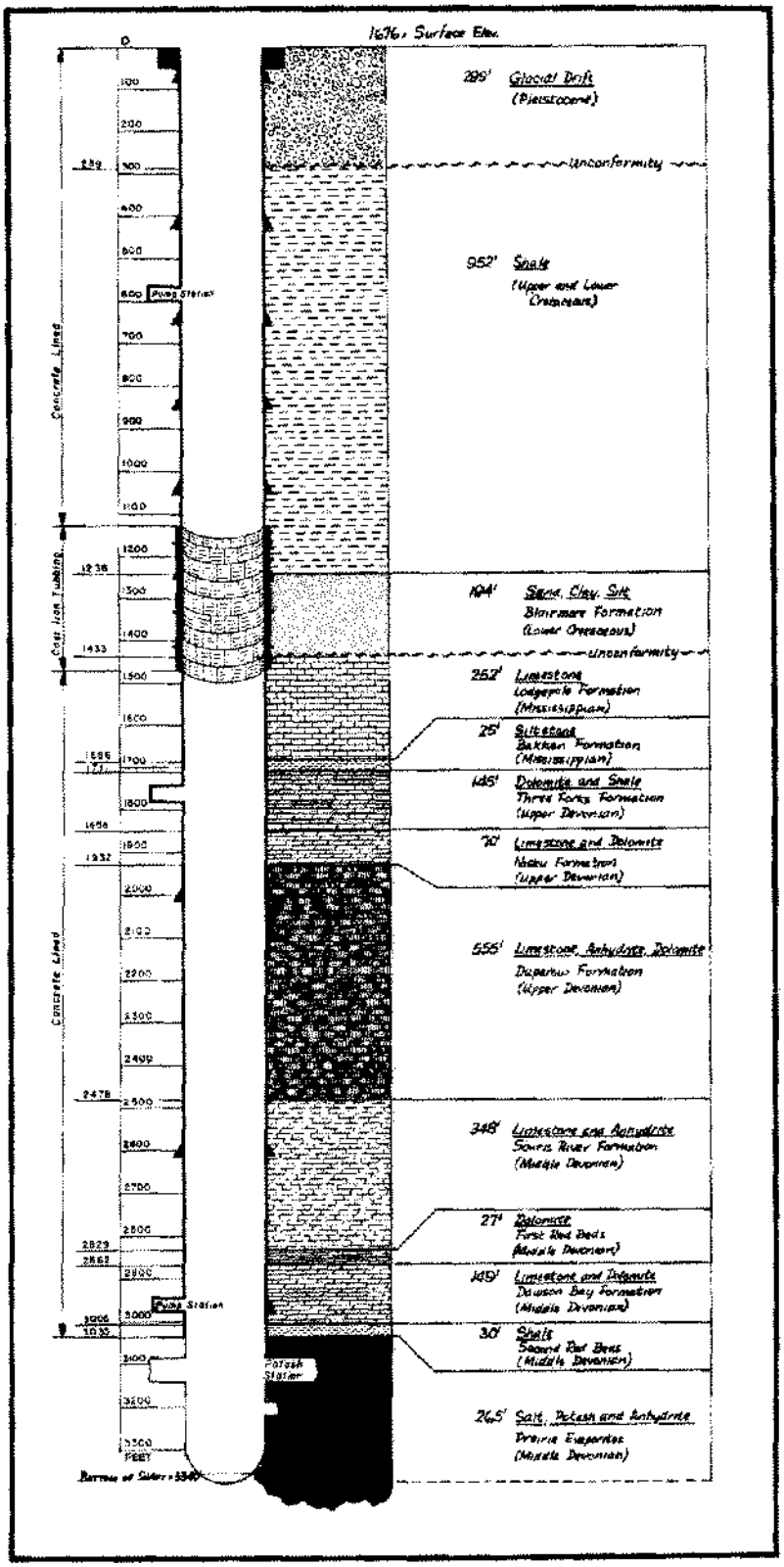

Figure 2. Yarbo Shaft Section.

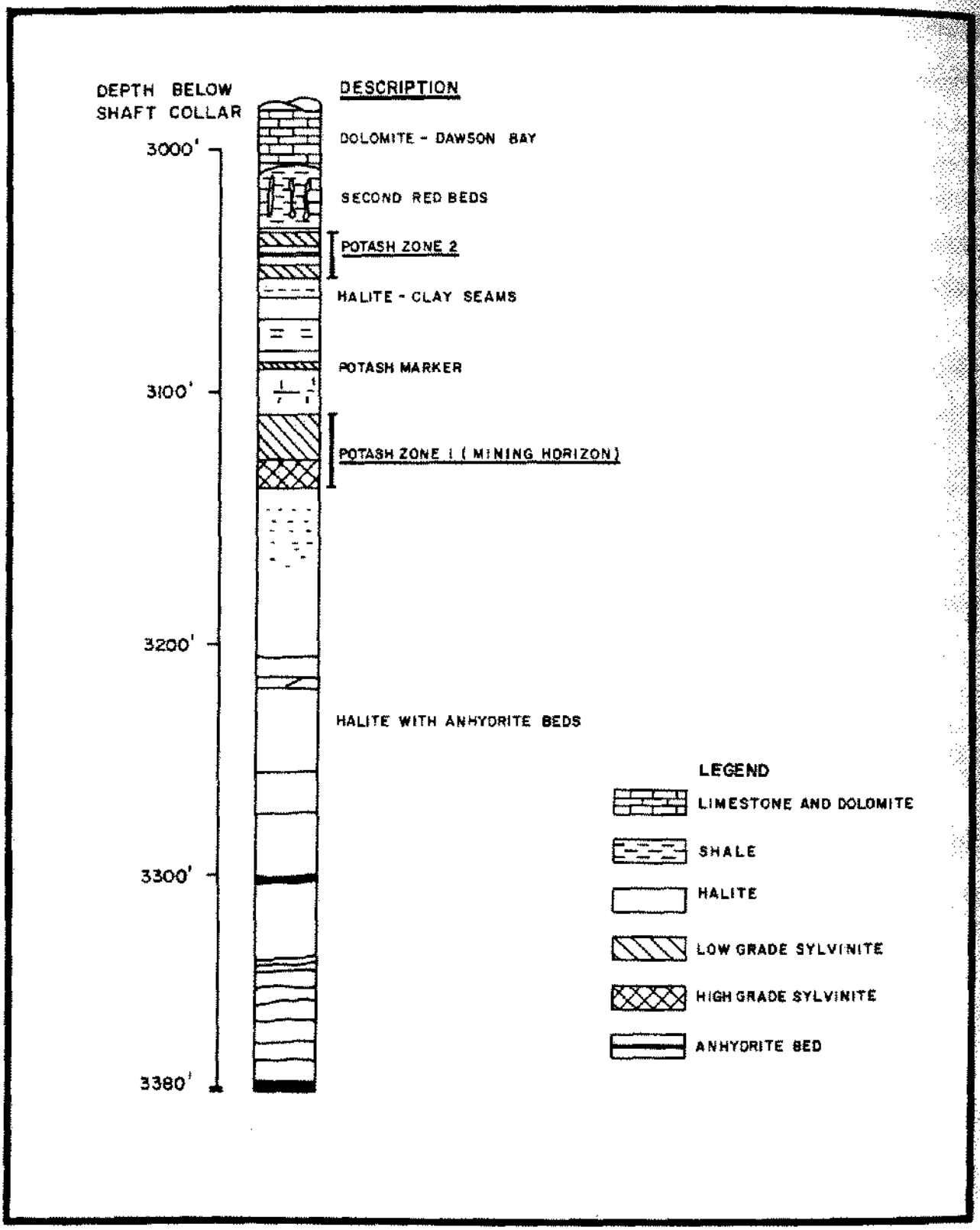

Figure 3. No. 1 Shaft Salt Section.

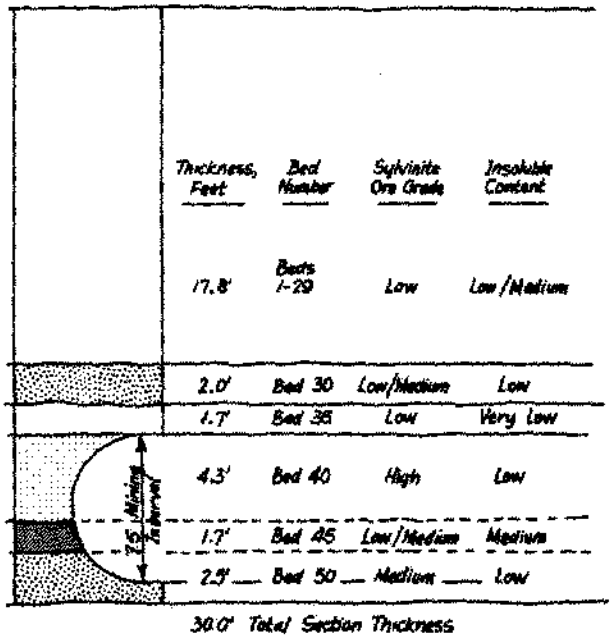

Figure 4. Typical Section -- Ore Zone 1.

Beds numbered 1 to 35, at the top of the zone, have a total thickness of 22 feet and consist alite, with some sylvite and carnallite, and up to 5% insoluble material. Beds 40 to 50 are inite and are described as follows:

The main ore bed, bed 40, contains the highest potash values with little or no insolubles. thickness, 4.3 feet, is remarkably constant throughout the mined area.

Bed 45, immediately below, is the operational marker horizon. It is darker in color than 40 because of its up to 3% insolubles content, and its potash grade is lower. The lower ore , bed 50, is similar to bed 40 but has a lower grade and sometimes a slightly higher insolubles tent.

There are no commercial potash values in the strata below.

rnallite

In certain areas of the mine the ore is carnallite-bearing. A typical section through a rnallitic zone is shown in Fig. 5. You will notice that the carnallite is distributed without gard to the bedding of the ore. It appears that all the ore may have been carnallitic at one time t that large areas have been leached, leaving carnallite "topography." Evidence of the mobilition of magnesium-rich brines is afforded by the presence of massive pods of carnallite which

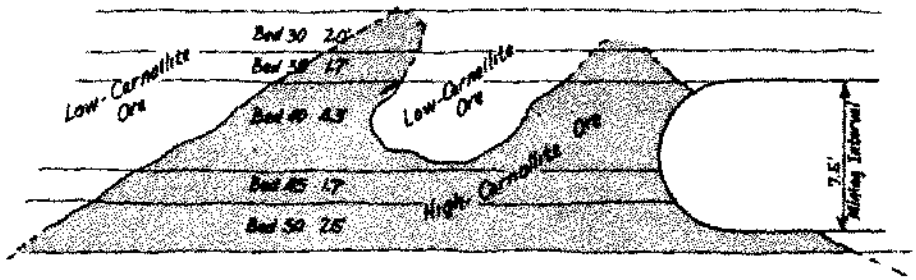

Figure 5. Generalized cross section through high-carnallite ore.

occur in random fashion in the ore beds. These pods are more or less round in section and up to six feet in diameter. The carnallite is often snow white, but may exhibit various shades of yellow, red, and purple. A halo of disseminated orange carnallite commonly borders each pod.

Salt Horses

Bodies of salt which interrupt sylvite mineralization in the ore horizon are referred to locally as salt horses. These salt horses are of interest both to the miner and the geologist. They are not a common feature of the mine workings, but there are several types (Fig. 6).

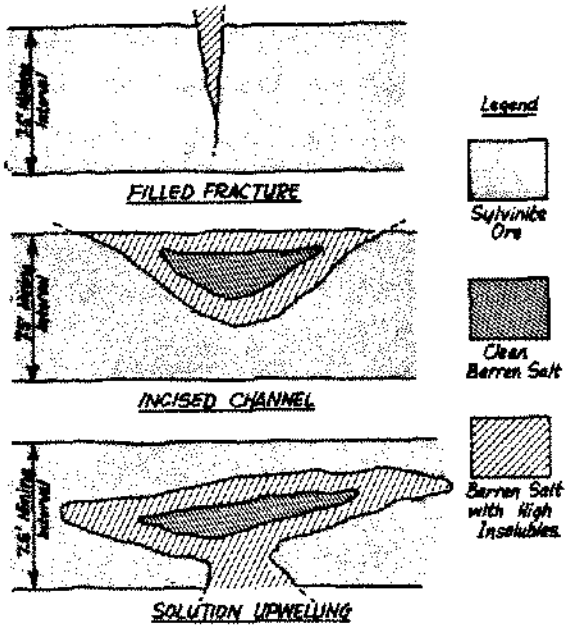

Figure 6. Section through three types of salt horse.

One type appears to represent the infilling of a sinkhole or channel. Where this has occurred under quiescent conditions the insoluble content has formed a coating on the bottom of the sinkhole. Where there has been movement, as in a channel, the insolubles have been swept away, leaving a clean contact zone. On the edges of the salt horse, the salt tends to have a greyish cast and may contain small crystals of red sylvite, but in the center there is likely to be a zone of pure translucent halite.

Salt horses of this type are found in areas of both high-carnallite and low-carnallite ore. However, it has been observed that even in the midst of high-carnallite ore the salt horse may have an "envelope" of carnallite-free ore around it. It is felt that this could be the result of leaching or carnallite by the brines which formed the salt horse.

There occurs in the mine, however, one salt horse, situated in a high-carnallite area, which has no leached zone around it. The carnallitic ore extends apparently unchanged to the salt horse contacts, and concentrations of carnallite occur within the horse itself. The insolubles content of this horse is very low.

In one case observed, the salty potash-deficient brines seem to have moved upwards through the ore beds. The sylvite rich beds have been replaced by a mushroom-shaped mass of coarsely crystalline halite.

Salt also occurs in the ore beds as the infilling of narrow cracks in association with sylvite and insolubles. The insolubles content is usually high enough to make the crack filling appear darker than the ore beds. These cracks have a very limited extent.

MINE GEOLOGICAL PRACTICE

The choice of a mining horizon at Esterhazy was made relatively easy by the consistency of the potash values in the various ore beds. The problem then becomes straightforward operational control to assure that the chosen horizon is closely followed in mining.

The top of clay-bearing bed 45 has proved to be a very useful marker. As a part of the daily operations, a member of the geological group checks the position of each continuous mining machine with respect to the marker horizon and submits a report to the Mine Superintendent and the Underground Superintendent.

Routine chip sampling of each bed at 100-foot intervals was instituted at the beginning of mining operations, and isograde maps of potash, carnallite, and insoluble content are maintained to provide the basic information required for mine planning and forecasting.

A structure contour map has been drawn on the top of bed 45 from the elevations of the sample stations. Attempts are being made to relate grade trends to structure. This map also provides useful engineering data for the laying out of conveyor belts and other equipment installations.

ACKNOWLEDGMENTS

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