Abstract

Potash occurs in the deep, center of the Michigan basin and contained exclusively in the Salina A-1 Evaporite formation as Sylvinite in the middle or upper portions of the formation. The Potash occurs as Sylvite (in relatively pure beds as much as 30 feet thick or as Sylvite (KCl) intimately intermixed with Halite (NaCl) as Sylvinite. These deposits were first described by Dow Chemical Company scientists in the early 1970’s, based on samples from a core in Midland County and nearby well Gamma Ray logs. The Potash zones are located between 7,000 and 9,000 feet deep and occur in all or parts of 17 counties in the northern half of Michigan’s Lower Peninsula.

Commercial Potash mining in Michigan began at a solution mining facility near Hersey, Michigan in 1997. The plant was designed for production of 160,000 tons of Potash per year primarily from a 20-30 foot thick interval, near the top of the A-1 Evaporite, of relatively pure Potash locally known as the “Borgen Bed”. The grade of this Potash deposit is one of the highest in the world at nearly 70% KCl by volume. It is also very pure containing negligible Carnallite and about 0.5% insolubles. Potash production at the Hersey mine ceased in 2013 although the facility still does produce Salt (NaCl).

In 2008, a significant collection of core from the A-1 Evaporite in the commercial mining area as well as throughout the northern half of Michigan was donated to Western Michigan University. The collection contained over 11,300 linear feet of conventional, 4-inch core sealed in plastic sleeves, from 77 different wells in nine counties. In addition to the cores, several hundred modern wireline logs are available from wells that pass through the Potash zone. Gamma Ray, Compensated Neutron and Lithodensity curves are all useful in defining the stratigraphic occurrence and approximate thickness of the Potash-bearing strata. The “Borgen Bed”, near the top of the formation is widespread in the western portion of the area, whereas there is a sequence of thinner Sylvite and Sylvite/Halite interbeds in the middle of the formation to the eastern portion of the area.

By supplementing the core data with wireline logs, it can be estimated that Michigan’s Potash deposits are contained in 17 counties in the central and northern part of the Michigan basin. Based on thickness of Sylvite intervals and grade values from core analysis, it is likely that commercial production can come from nine counties representing 2.9 million acres.
References Cited


Occurrence of Potash-bearing strata (Sylvinitite) in the Salina A-1 Evaporite in the Central Michigan Basin

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Michigan Geological Survey
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2014 Annual Meeting
London, Ontario, Canada
U.S. Potash Facts

• Potash ($K_2O$) refers to a group of potassium bearing minerals, the most common being potassium chloride ($KCl$). Potassium ($K$) is the seventh most common element in the earth's crust, and is found in every cell of plants and animals and is essential to their growth.
• 2012 U.S. Production – 900,000 tons
• 2012 production value - $675 million (@$750/ton)
• 2012 Imports – 4,000,000 tons
• Import Sources – Canada – 84%, Russia – 11%
• Potash produced in Michigan (recently closed), New Mexico, and Utah. Most production from New Mexico
U.S. Potash Demand for Agriculture

Tons per sq mile

Source: USGS
U.S. Potash Production and Consumption Statistics

U.S. Potash Production and Consumption 2008-2012

Production and Consumption in 1,000's Tons

Underground Potash Mine in Saskatchewan, Canada

Mosaic Michigan Potash Solution Mine Hersey, Osceola Co.
Occurrence of Michigan Potash strata

- Contained exclusively in the Salina A-1 Salt Formation in the Michigan Basin
  - Interbedded as relatively pure Sylvite (KCl) beds within Halite (NaCl) in the upper half of the formation
  - Geographically located in basin center at depths between 7000 and 9000 feet deep
  - Some Potash beds occur in all or parts of 17 counties, but commercial quantities may be limited to about 8 counties
Michigan Stratigraphic Column

- Shallow Marine Shelf
- Carbonates capped by Reefs
- Restricted Marine
- Carbonates interbedded with Evaporites
- Shallow Marine Shelf Carbonates capped by Reefs
Distribution of Middle Silurian Environments, Michigan Basin

Gill, 1977

Ritter, 2008
Historic Studies of Michigan Potash

- Dow Chemical Co. research group in late 1966 sampled core in Dow Chemical #8 Salt Well in Midland Co. Compared it to the Gamma Ray log of the Pure-Merton-Emery #1 well 11.4 miles to the SW
- Matthews, 1970 and Matthews and Egleson, 1973 mapped the distribution of Potash in the A-1 Salt using wireline logs and brine analyses
- Matthews, 1970 suggested that Potash occurred in parts of 22 counties covering over 13,000 sq. mi. (over 8,000,000 acres)
- Elowski, 1980, most recent overview
Wells that Penetrate the A-1 Salt In the Michigan Basin
Structural Contour Map on top of Salina A-1 Salt Formation – Depths in Subsea
General Geographic area of occurrence of Potash Beds in Michigan Basin

- Estimated areal extent of Potash Beds: Roughly 8 Counties, 4,600 sq.mi., 2.9 million acres
- Estimated area with Commercial Potential: 17 Counties
Boreholes with Wireline logs useful for assessing occurrence of Potash Beds
Stratigraphic Occurrence of Potash Beds in Salina A-1 Salt

- Potash is present in two distinct portions of the A-1 Salt
- “Borgen Bed” – Thick (up to 30 ft.) of relatively pure Sylvite, near the top of the formation
- “Basin-Centered Beds” – several to numerous thinner and slightly lower grade Sylvite in the middle or upper third of the formation
NW to SE Cross Section Through Potash Bearing Zone

Michigan boreholes with Wireline logs
A-1 Salt Core Collection

• In 2008 the entire core collection from Mosaic Corp. (previously drilled by PPG and IMC) was transferred to Western Michigan University.
• Total of 77 wells comprising 11,380 feet of cored material
• Cores sealed in poly bags and untouched since initial coring and sampling for analyses
Park # 1-12 Core Showing Primary Depositional Layering in Halite
Sylvite occurrence in the A-1 Salt

- May be as pure Sylvite beds interbedded with Halite or as intimately intermixed halite and Sylvite crystals in the same bed
- Visual estimation of Sylvite and Halite percentages can be made on exterior of core due to the relative difference in solubility of the two minerals during the coring process with Halite saturated drilling fluid
Assay Analysis of Potash Grade

• Some samples of split core portion (1/4 or 1/8) of whole core
• Most samples were from powder drilled from fresh core surface in the interior of a split core
• Half meter to one meter sampled continuously
Quality Control on Analyses

- Replicate and duplicate samples were analyzed
- Solid core chunks as well as drilled powder samples from the same interval were compared
Potash from “Borgen Bed” Interval

Visual Volume estimate: This foot long piece of core averages approximately 52.1% KCl or 32.4% K₂O (Average Borgen Bed assay is 58.7% KCl)

- 3.5” - 50:50% – KCl+NaCl – 14.58
- 1.5” - 100% - NaCl – 0.00
- 1” - 50:50% - KCl+NaCl – 4.17
- 1.75” – 100% - KCl – 14.58
- 2.5” - 50:50% – KCl+NaCl - 10.41
- 1” – 100% - KCl – 8.33
- 1” - 100% - NaCl – 0.00

Cored interval shown:
7668.5-7669.5

Willmet-Gray #1-31
Osceola Co. 31-17N-8W
P#35800
A-1 Evap Core: 7593-7854 ft
Portion of Core through Basin-Centered Beds in Osceola County

Visual Volume Estimate:
This eight inch piece is approximately 37.5% KCl or 23.7% K₂O

1” - 50:50% – KCl+NaCl – 6.25
1” – 100% - KCl – 12.50
2.5” - 100% - NaCl – 0.00
1” - 50:50% – KCl+NaCl -6.25
1” – 100% - KCl – 12.50
1” - 100% - NaCl – 0.00
General Geographic area of occurrence of Potash Beds in Michigan Basin

Estimated areal extent of Potash Beds

- Roughly 8 Counties
- 4,600 sq.mi. 2.9 million acres
- 17 Counties
Summary of Michigan Potash

- Occurs only in the Salina A-1 Salt in the center of Michigan basin,
- 8 counties have thickest, many areas may have recoverable deposits
  - Missaukee, Roscommon, Clare, Osceola, Gladwin, Midland, Isabella, Mecosta
    (Approximately 2,900,000 gross acres)
- Two main target horizons – Estimated through volumetric observations of %KCL
  - “Borgen Bed” - Generally one continuous bed 10 to 30 feet thick, Average estimated volume calculation from core observation:
    - 55% KCL or 35% K₂O – Primarily NW side of Basin
  - Basin-Centered Beds – Numerous thin beds (inches to a few feet thick) gross interval 70 to 150 feet thick, net log measured potash thickness 40-70 feet Average estimated volume calculation from core observation:
    - 43.8% KCL or 27.7% K₂O
- Comparison to other world potash production grades
  - Canada – 18% – 24% K₂O
  - Utah – 24% K₂O
  - New Mexico – 8% - 22% K₂O
  - Russia – 18% - 22% K₂O