The Potash Report

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New maps

The North Dakota Geological Survey (NDGS) has released a new set of maps depicting the potassium oxide (K_20) percent concentrations of various wells for each of the potash-containing members of the Prairie Formation on the Crosby 100k-series sheet (Kruger, 2018). These maps include updated isopach thickness projections of the members. Potassium oxide concentrations can be estimated based upon the gamma-ray response from electric logs, with corrections made for borehole size and drilling mud weight (Crain, 2014). Gamma-ray logs are also useful for the easy identification of potash-rich intervals of potassium-containing minerals such as sylvite and carnallite. The gamma-ray recording of the natural radioactivity of potassium stands out from the non-radioactive halite (sodium chloride) deposits which sandwich potash layers from above and below. Potassium oxide maps for additional 100k-series maps will be forthcoming.

Potash in North Dakota

North Dakota remains an untapped resource for potential potash production. As described by Murphy (2011) in a previous edition of Geo News, thick salt deposits accumulated over the wide expanse of the Elk Point Basin during the Middle Devonian some 400 million years ago, when waters extended down to the northwestern portion of modern-day North Dakota. At times, when water circulation was impeded, potassium salts would precipitate out of dense brine and accumulate into distinct layers within the larger salt body. These potash-rich zones are found in the subsurface in areas of Saskatchewan, Manitoba, Montana, and North Dakota in a rock unit named the Prairie (Evaporite) Formation.

The Prairie Formation was deposited in broad horizontal layers, but due to the structural development of the Williston Basin, the Prairie Formation dips inward toward the center of the basin. As a result, the Prairie Formation is closer to the surface in Saskatchewan than it is in North Dakota, where its depth below the surface ranges from 5,600 feet (1,700 m) in northwestern Bottineau County to greater than 12,500 feet (3,800 m) in southern McKenzie County and northwestern Dunn County (fig. 1). Prior to 2014 it was assumed that the potash layers in North Dakota were extensions of the Esterhazy, Belle Plaine, and Patience Lake Members which are mined in Saskatchewan. At the time, the potash layer referred to as the Mountrail Member in North Dakota had not been correlated across the Canadian border, but was considered likely to be the stratigraphic equivalent of the Patience Lake Member (Anderson & Swinehart, 1979). Subsequently, a NDGS investigation of the Prairie Formation made these cross-border correlations and found that the Mountrail member was a distinct layer which does not extend into Saskatchewan and overlies the Patience Lake member by 68 to 143 feet (21 to 44 m) (Kruger, 2014). It was also found that the White Bear Member, present in the southeastern corner of Saskatchewan, but thinning to the status of a marker bed in the Canadian mining region (Fuzesy, 1982), is the most prominent of the potash-containing beds in North Dakota. Finally, a sixth, thin potash bed of very limited areal extent was identified stratigraphically above the other members and was named the White Lake Member (fig. 2).

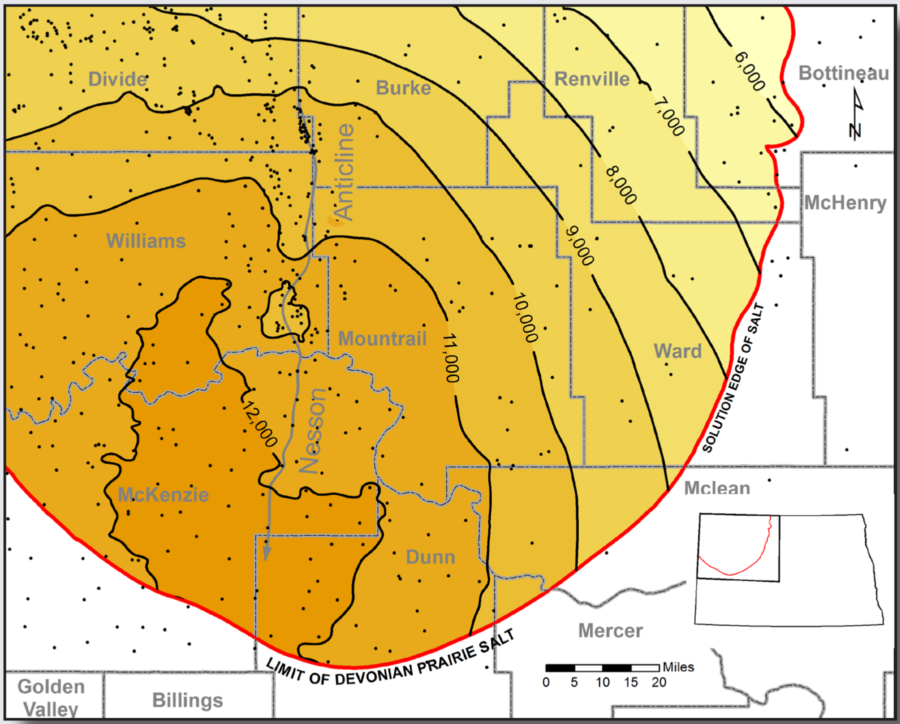

Figure 1. Depth from the surface (in feet) to the top of the Prairie Formation in North Dakota (Kruger, 2014).

The thickest potash deposits in North Dakota are found in a region east of the Nesson anticline from the northwest corner of Burke County to the center of Mountrail County, where the cumulative thickness of all six potash-containing members net of the interbedded halite reaches a maximum of 47 feet (14 m) (fig. 3). The two uppermost White Lake and Mountrail Members are of lesser economic importance due to their vertical separation from the lower, thicker members. In locations where all of the lower members are present, they typically appear as one set of closely spaced potash beds (the Patience Lake and Belle Plaine) separated by about 40 feet (12 m) of halite from a second set of potash beds (the White Bear and Esterhazy) (fig. 2).

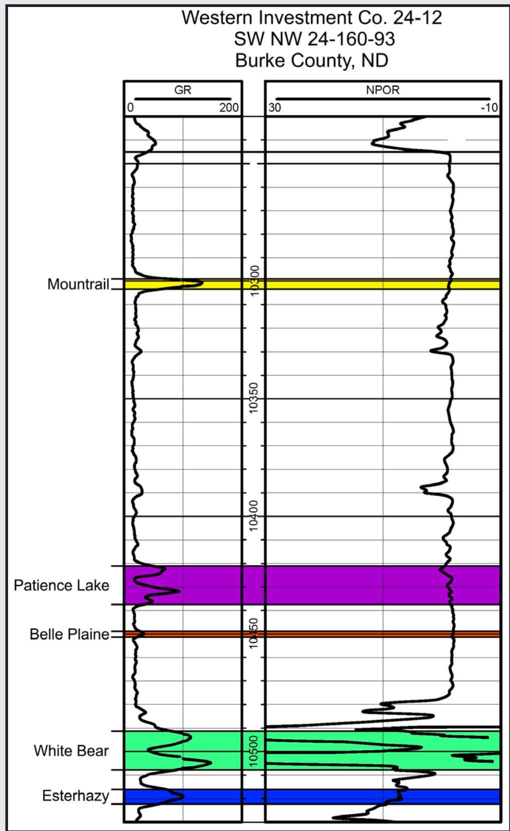

Figure 2. Log profile of Western Investment Co. 24-12 in Burke County showing the stratigraphic relationships of five of the six potash-containing members present in North Dakota. Where observed, the White Lake Member overlies the Mountrail Member by 31 to 90 feet (9 to 27m) (modified from Kruger, 2014).

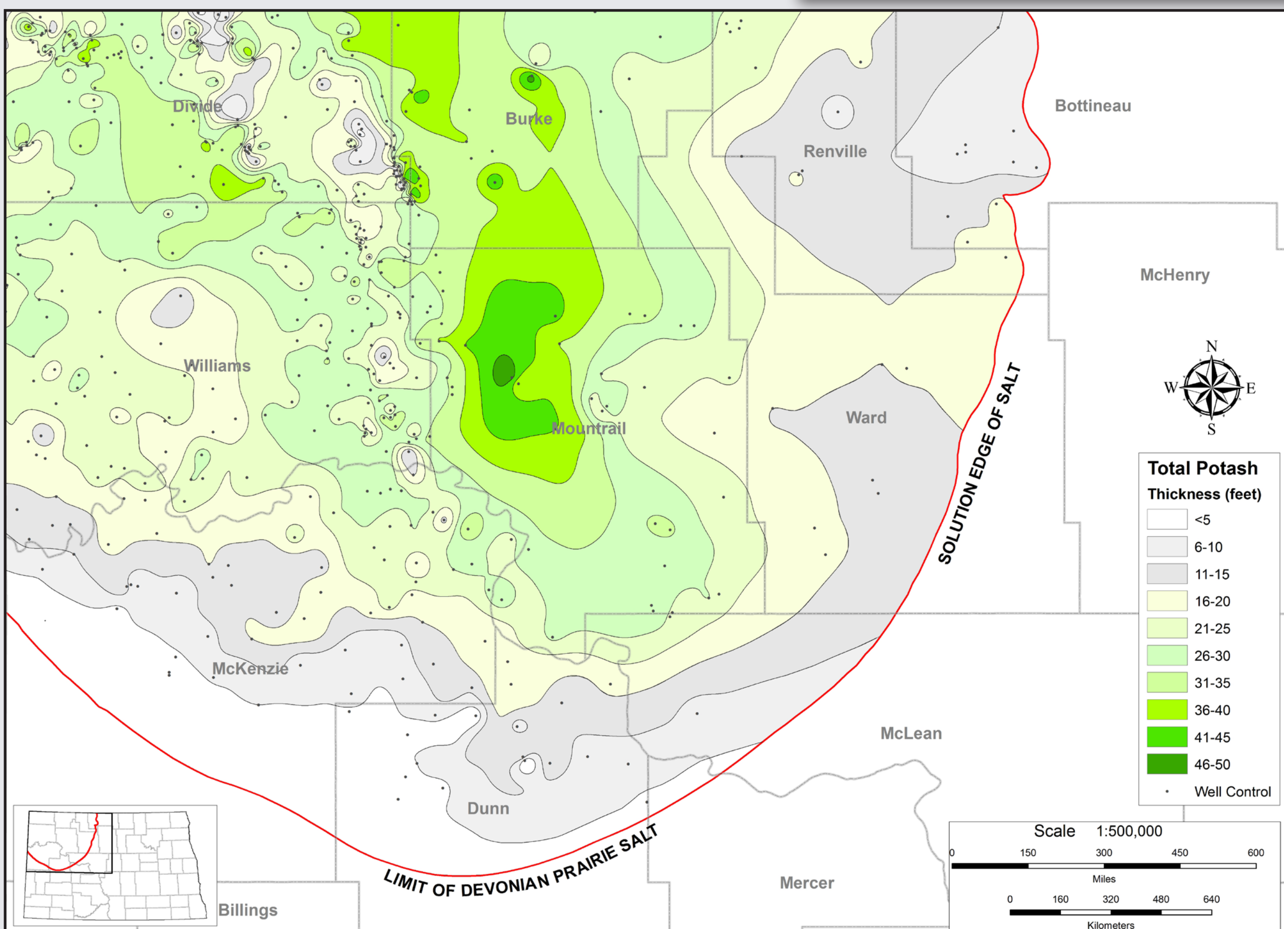

Figure 3. Contour map showing the cumulative thickness of all potash beds, net the thickness of halite interbeds which separate the members.

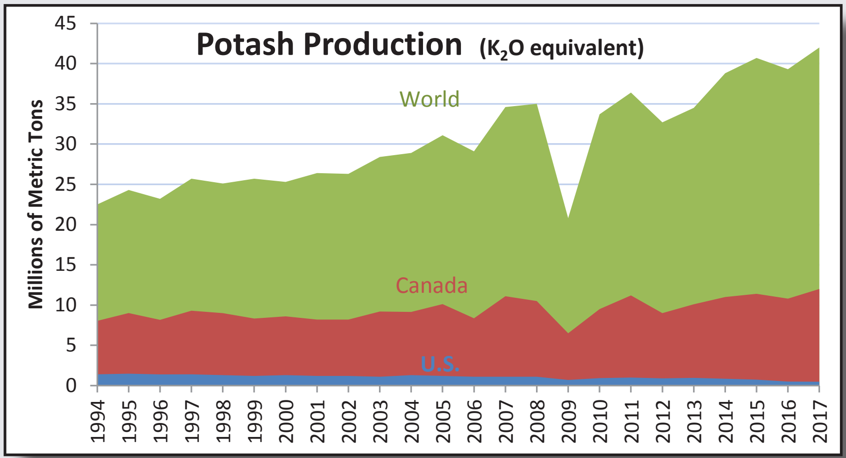

Figure 4. World, Canadian, and U.S. production of potash from 1994 through 2017. Source: U.S. Geological Survey Mineral Commodity Surveys.

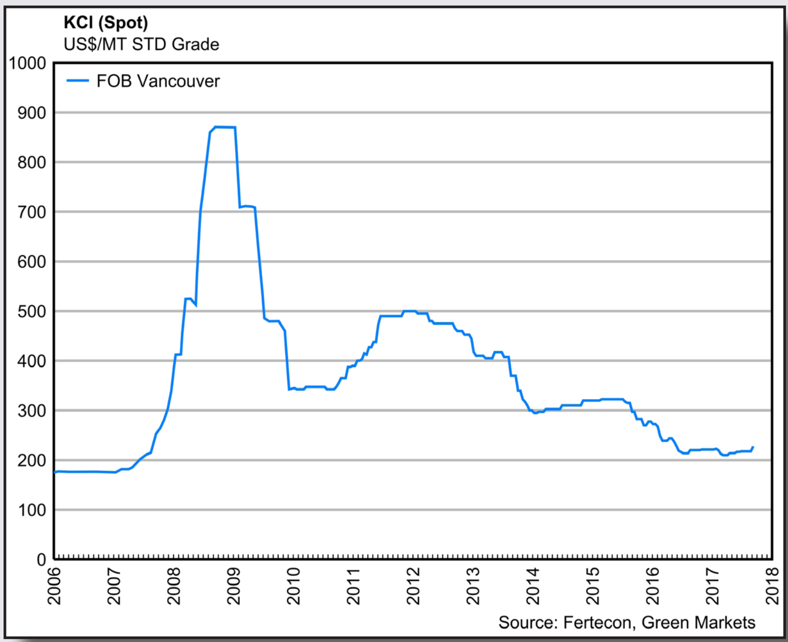

Figure 5. Potash spot market prices from 2006 to 2017. Source: Fertecon, Green Markets.

Recent Production and Pricing

A general uptrend in potash production has transpired over the past several years, with year over year production increases occurring in five out of the seven years from 2010 to 2017 (fig. 4). Over this time period, world production increased from 33.7 to 42.0 million metric tons, yielding a total increase of 25% and an average annual increase of 3.5%. Over the same time period, North American production rose from 10.4 to 12.5 million metric tons, equating to an increase of 20% or an average annual increase of 2.9%. The North American increase is primarily driven by Canadian production gains, as production in the U.S. during this period dropped by 48%, and is down 68% from its high of 1.48 million metric tons in 1995. The recent steep decline in U.S. production is mainly attributable the closure of the Mosaic mine in Michigan in late 2013 (Jasinski, 2014), and the indefinite closure of one underground mine and restructuring of a second, both located in New Mexico (Jasinski, 2017).

While production has increased at a moderate pace, potash commodity prices have continued a general downward trend since 2012, perhaps bottoming out in 2017 as prices rose through the latter portion of that year (fig. 5). Despite recent prices being significantly lower than those which were projected back in the mid-2000s (Murphy, 2011), worldwide exploration and development remains active with 30 projects reported to be in progress in 2016 (Jasinski, 2017). Expansions of existing mines and new mines have come online in recent years though some projects have delayed production-date expectations.

References

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