North Dakota's Lignite Reserves Published

by Ed Murphy

North Dakota's Mapped Lignite Reserves

This summer North Dakota became the first state to publish maps of all of its mineable (also spelled as minable) lignite reserves at a scale of 1:24,000. A number of organizations and agencies track the world's mineral reserves and under their various definitions the lignite deposits that we have mapped in North Dakota would be considered proved or proven recoverable reserves (World Energy Council), proved reserves (International Energy Agency and BP Statistics), or estimated recoverable reserves (U.S. Energy Information Agency). For the purposes of this article, I have simplified proved recoverable coal (includes all ranks of coal: anthracite, bituminous, subbituminous, and lignite) reserves to read *coal reserves* and proved recoverable lignite reserves to read *lignite reserves*. Over the past five years, we have published 287 maps (using USGS 7.5-minute quadrangles as the base) containing all of North Dakota's lignite reserves (figs. 1 and 2). These maps are available in both electronic and paper formats and can be downloaded as pdfs from the North Dakota Geological Survey's (NDGS) website.

Seams of lignite underlie the western half of North Dakota to a maximum depth of about 1,800 feet (549 m). Only those beds of lignite within 150 feet (46 m) of the surface are generally considered economically mineable when applying today's surface mining technology. Although underground mining was dominant in North Dakota from the late 1800s to the 1940s, lignite has not

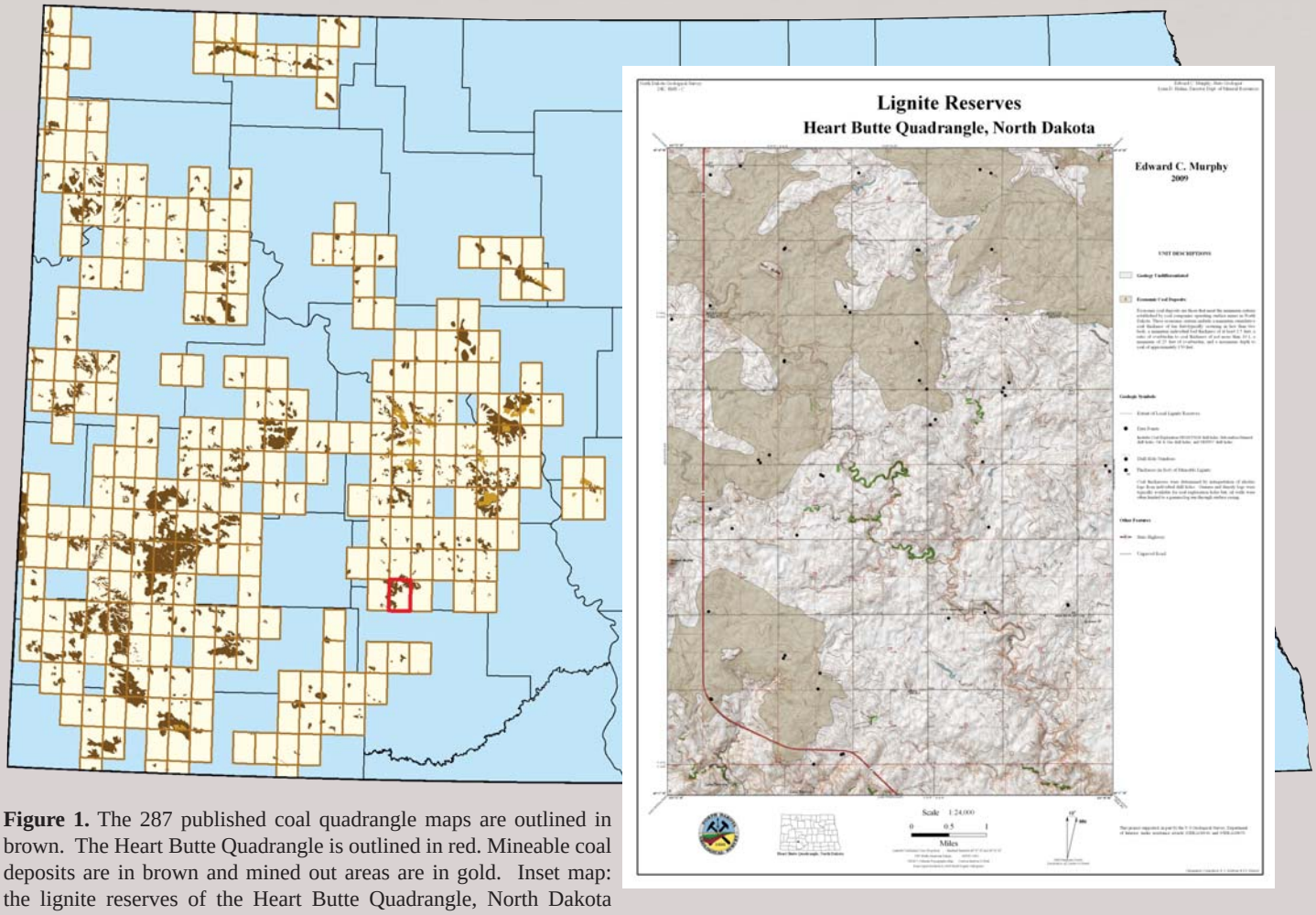

Figure 1. The 287 published coal quadrangle maps are outlined in brown. The Heart Butte Quadrangle is outlined in red. Mineable coal deposits are in brown and mined out areas are in gold. Inset map: the lignite reserves of the Heart Butte Quadrangle, North Dakota published in 2009.

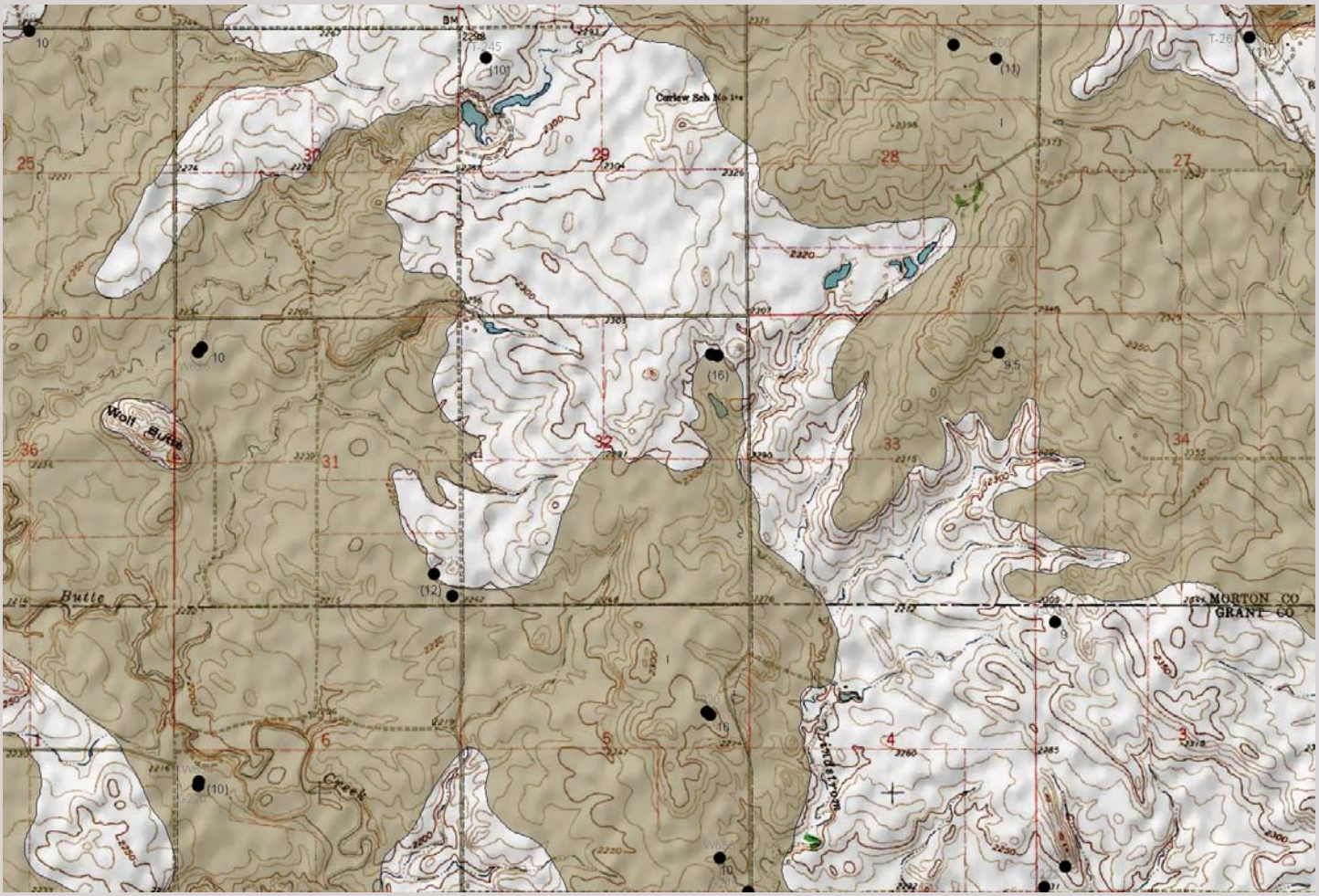

Figure 2. A portion of the Heart Butte coal map. The areas in brown indicate lignite reserves and the black dots are drill holes. The numbers adjacent to the drill holes are mineable coal thicknesses. If these numbers are in parentheses it signifies that it is a cumulative thickness of two beds.

been mined in North Dakota by underground methods since 1966 (Murphy, 2001). The 25 billion tons of lignite reserves that have been identified by the North Dakota Geological Survey and plotted on these maps can all be economically mined by surface methods (Murphy, 2006). These deposits were delineated using a database of 20,000 geophysical logs obtained from coal and uranium exploration test holes, oil and gas wells, NDGS test holes, and North Dakota State Water Commission monitoring wells. For beds of lignite to qualify as lignite reserves, they had to meet the following criteria:

1. more than 20 feet (6 m) below the surface, but no more than 150 (46 m) feet deep,
2. a minimum cumulative coal thickness of 10 feet (3 m) in no more than two beds of which no bed could be thinner than 2.5 feet (0.8 m), and
3. an overburden (depth from the surface to the top of the coal) to coal thickness ratio of no more than 10:1.

U.S. and World Coal Reserves

The United States contains 243 billion tons of coal reserves, substantially more reserves than any other country in the world. The U.S. coal reserves are more than one and one-half times those of the Russian Federation (157 billion tons), twice those of China (114 billion tons), three times those of Australia (76 billion tons), and four times those of India (58 billion tons). While North Dakota's 25 billion tons of lignite reserves are only 10% of the U.S. coal reserves, it accounts for more than 80% of the U.S. lignite reserves of 30 billion tons (World Energy Council, 2007). According to the World Energy Council, there are 150 billion tons of lignite reserves in the world. North Dakota contains almost 20% of the world's lignite reserves and Australia is the only country, at 37 billion tons, that contains more (fig. 3).

Lignite Resource of North Dakota

In 2006, the North Dakota Geological Survey determined that the total amount of lignite in North Dakota, or North Dakota's lignite resource, is 1.27 trillion tons (Murphy et al., 2006). Of this entire amount, only 2% (25 billion tons) can be economically recovered by surface mining. Far from being academic, the total amount of coal that is within 1,800 feet (600 m) of the surface in western North Dakota holds potential for a variety of uses including coalbed methane, in situ gasification, and carbon sequestration.

The Numbers Game

North Dakota's 1.27 trillion tons of lignite resource and 25 billion tons of lignite reserves can be viewed as important pieces of the world coal puzzle, especially when it comes to soft coal. Just like the saying "all politics is local", so it is when it comes to the amount of coal in the world. North Dakota is one of the few states that has accurate numbers, perhaps one of the few places on Earth. The reasons that other states and countries have not generated these numbers may be a combination of factors, including inadequate

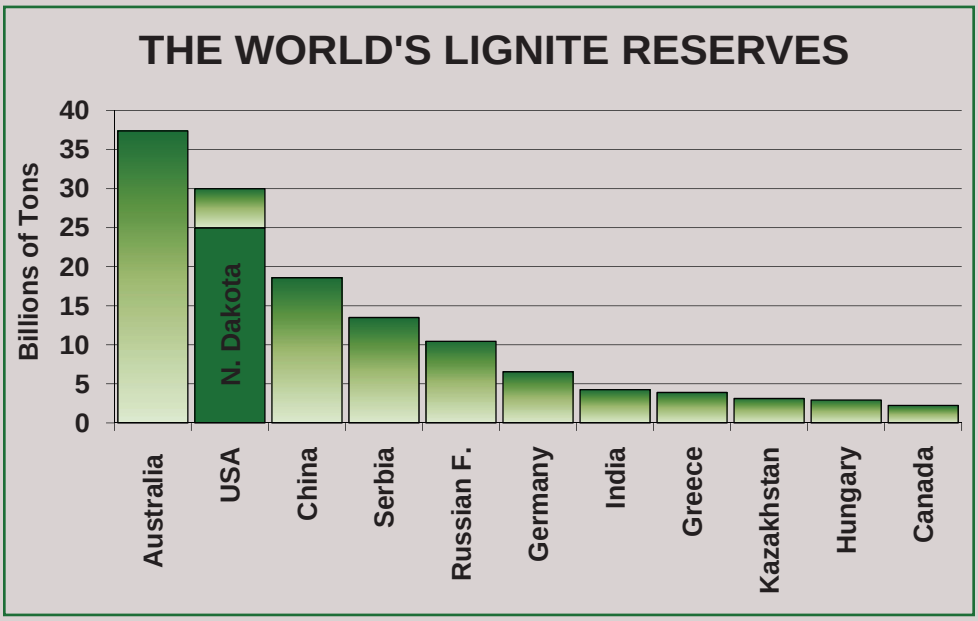

Figure 3. The lignite reserves (proved recoverable) of the top eleven countries. The United States has 30 billion tons of lignite reserves of which 25 billion are in North Dakota. Source: World Energy Council.

drill hole information, lack of manpower, reserve estimates have been given a low priority because there is more than a century's supply of coal in the world, and these numbers can quickly become outdated due to changing technological or economic conditions.

In general, we would expect the world's coal reserves to increase over time as advances in technology drive down mining costs making marginal deposits economic. This generally has not happened. Just ten years ago I used to routinely quote the statistic that the world had a 200-year supply of coal and the U.S. a 227-year supply. Recently that time frame has dropped to 123 years for the world and 205 years for the U.S. What happened to all of that coal? The short answer is it was never there or, more correctly, it was never there economically. Most recently, when countries have recalculated their coal reserves they have tended to report lower volumes than previous calculations. That is why over the last decade the world's coal reserves have dropped from 984 billion tons to 826 billion tons (fig. 4). For example, India announced in 2006 their coal reserves were 56 billion tons rather than the 92 billion tons they had reported in 2003. Also, between 2000 and 2008, Germany's coal reserves were revised from 66 billion tons to 7 billion, South Africa's dropped from 50 billion to 30 billion tons, Poland's from 22 to 8 billion tons, and reserves in the United States were reduced from 250 to 238 billion tons (World Energy Council, 2001, 2004, 2007, 2009). A comparison of these gross tonnages is sufficient for this discussion, but to paint a more accurate picture of the world's declining reserves you must compare the heating values of the various ranks of coal that are being added or subtracted from that estimate.

Another reason the remaining years of world coal production are declining is because we are consuming more coal than ever before. World annual coal production hovered around 5 billion tons from 1985 to 2002. Between 2003 and 2008 world production increased 40% to over 7 billion tons (Energy Information Administration, 2009). China was responsible for half of that increase. The U.S. mines roughly 1.1 billion tons of coal annually. Wyoming accounts for 468 million tons of that (40%) while North Dakota produces about 30 million tons and ranks tenth amongst states. At our current rate of production, North Dakota has about 830 years worth of coal.

The Value of Coal Reserve Maps

Accurate inventories of the world's natural resources are extremely important. Whether it be coal, oil and gas, geothermal, uranium, water, etc., the world needs accurate natural resource assessments in order to predict future supplies.

We had anticipated that the published maps of North Dakota's lignite reserves would be utilized by mineral companies, government agencies, and landowners. In addition to those traditional usages, we have been encouraged that companies have also used them to avoid locating wind turbines or establish pipeline corridors within areas that may someday be mined. Siting of infrastructure over mineral reserves, be it coal, clay, limestone, or sand and gravel, can preclude all or part of a natural resource from being developed in the future and it is a serious international problem. The utilization of reserve maps such as these can help to minimize that problem.

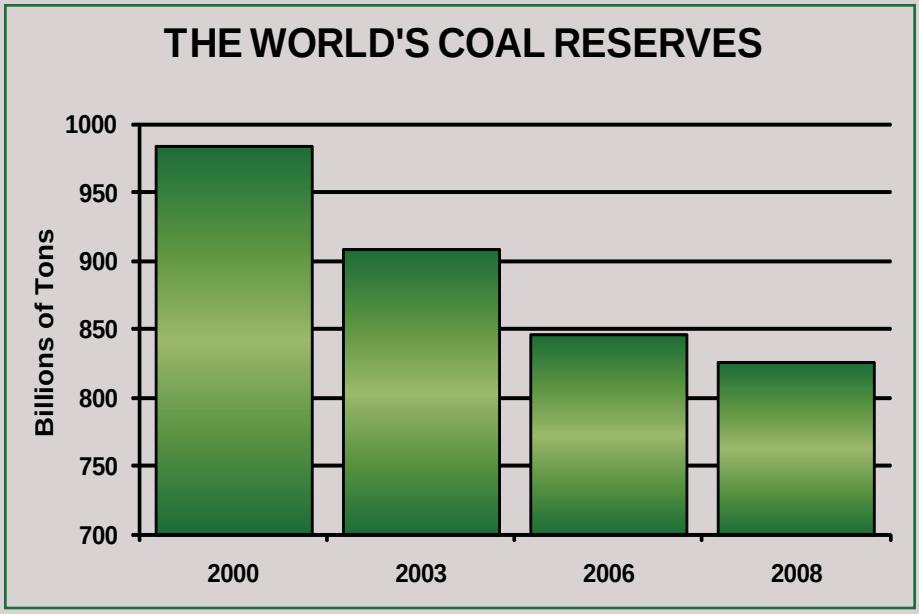

Figure 4. The World's declining coal reserves (proved recoverable) from 2000 to 2008. Source: World Energy Council.

References

Energy Information Administration, 2008, International Coal Production 1980-2007, U.S. Department of Energy: http://www.eia.doe.gov/emeu/international/coalproduction.html, posted October 17.

Energy Information Administration, 2009, International Energy Outlook 2009 – Chapter 4 Coal, U.S. Department of Energy Report no. DOE/EIA-0484(2009), p. 49-62.

Murphy, E.C., 2001, Strippable lignite deposits of North Dakota: North Dakota Geological Survey, Miscellaneous Map no. 34, scale: 1:1,000,000.

Murphy, E.C., 2006, The lignite reserves of North Dakota: North Dakota Geological Survey, Report of Investigation no. 104, 141 pp.

Murphy, E.C., Kruger, N.W., Goven, G.E., Vandal, Q.L., Jacobs, K.C., and Gutenkunst, M.L., 2006, The lignite resources of North Dakota: North Dakota Geological Survey, Report of Investigation no. 105, 31 pp.

World Energy Council, 2001, Coal (including lignite) in Survey of energy resources: 19th Edition, Regency House, London, p. 1-30.

World Energy Council, 2004, Coal (including lignite) in Survey of energy resources: 20th Edition, Elsevier Ltd, Kidlington, Oxford, p. 1-30.

World Energy Council, 2007, Coal in Survey of energy resources: 21st Edition, World Energy Council, London, p. 1-40.

World Energy Council, 2009, Coal in Survey of energy resources, interim update 2009: World Energy Council, London, p. 1-7.

STAFF NEWS

The Oil & Gas Division has welcomed six new employees since July.

Bismarck office

Lisa Petersen, who we introduced in the last newsletter, accepted a full-time position as an Office Assistant in August. Originally from Bismarck, Lisa has also lived in Arkansas (where she went to school) and Kansas but in the end, like so many other North Dakotans, found the lure of the northern plains too powerful to resist and came home. She has three sons: Steven (18), Dillon (17), and Hunter (12), yet still finds time to enjoy hobbies that include painting, woodworking, and horseback riding.

Jamie Lien joined the Oil & Gas Division in September as an Office Temp. Jamie is from Fessenden, where she graduated from High School in 2006. Her young family includes 1-year-old Colin, and his big sister Tristen, who is 2.

The Bismarck office's most recent hire is Tim Mork, who started as an Engineering Tech 3 in October. Tim, who is from Mandan, graduated from Bismarck State College with an Associate of Applied Science degree and also holds a B.S. in Operations Management from Minnesota State University Moorhead. After a brief sojourn in Iowa, he returned to the Bis/Man area as regional project manager for Florida Power and Light, a major investor in alternative energy resources including wind power. Having now given up his seven-state region for just one, Tim is quite happy to be spending more time close to home.

Dickinson field office

Ryan Dayton has been a field inspector with the Oil & Gas Division since August. He is from Cumberland, Wisconsin and is currently a master's candidate in geology at the University of Minnesota Duluth, having already obtained his bachelor's degree at the University of Wisconsin Eau Claire. Between finishing his first degree and starting the second, Ryan and his wife Karilyn spent two memorable years in Guatemala with the Peace Corps. While in graduate school, he was awarded a GK-12 Graduate Teaching Fellowship with the National Science Foundation to help improve science literacy in local high schools.

In September Nicole Nelson also joined the Dickinson office as a field inspector. Nicole is from Minot and a graduate of Minot State University with degrees in geology and chemistry. Before becoming a field inspector for the Oil & Gas Division she was a mud logger with Weatherford International, and is therefore no stranger to North Dakota's oil patch.

Williston field office

Jessica Stalker was hired in October, bringing the Oil & Gas Division's number of field inspectors to its full complement of fourteen. Jessica was born in Pennsylvania but lived in many states before her family decided to settle in West Virginia. She lived there till 2005, when she graduated from West Virginia University at Morgantown with a B.S. in geology. Jessica moved to North Dakota from Wyoming where she worked as a geologic and environmental consultant with Tetra Tech.