Germanium in North Dakota Lignites

By Ed Murphy

Introduction

Germanium is a semi-metal or metalloid that has electrical properties between those of a metal and those of an insulator. This semiconductor is used in the manufacturing of solar panels, fiber optics, infrared sensors, high speed electronics, and PET plastics. In the U.S., germanium is primarily used in infrared optics, fiber optics, and electronic and solar applications (Guberman, 2008). Because of germanium's efficiency in solar applications, the majority of solar cells in satellite applications have germanium-based substrates. In 2009, an Australian company, Solar Systems, is planning to apply this space-based technology when it begins construction on a 154 MW solar power station in Victoria, Australia, touted to be the largest and most efficient photovoltaic power station in the World. The company states that the technology they have developed has the ability to concentrate the energy of the sun by 500 times onto the solar cells (Solar Systems, 2008). Such applications could significantly increase future demands for germanium.

The U.S. Geological Survey (USGS) estimated that worldwide production of germanium in 2007 was 220,000 pounds and came primarily from the smelting and refining of zinc ores. There is also some worldwide production of germanium from the processing of fly ash from coal-fired boilers, but no current germanium/flyash production in the U.S. The USGS estimated that in 2007, the United States consumed 132,000 pounds of germanium; 86% (115,000 pounds) of this was imported. U.S. germanium imports doubled between 2005 and 2006, most of it coming from Belgium, Germany, Russia, China, and Canada. The value of germanium dioxide (GeO_2) increased 30% during 2007, ending at $450 per pound (Guberman, 2008).

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In the 1950s and 1960s, both the USGS and the ND Geological Survey noted the presence of germanium within coals of the Fort Union Group (Hansen, 1964; Anderson, 1973). In 1953, Stadnichenko and others reported North Dakota lignites contained between 0.0005 and 0.043% germanium, reported as a percentage of the coal ash. They analyzed 84 coal samples from seven localities in western North Dakota, including the Baukol-Noonan mine in Divide County, the Coteau mine in Burke County, the Custer Mine in McLean County, the Dakota Star and Beulah mines in Mercer County, and several samples from western Oliver County. All of these mines ceased operation decades ago. The highest concentrations of germanium came from the base of a thin coal overlying the Noonan bed in the Noonan Mine (0.03% germanium in ash with an ash percent of 7.28) and the base of the Custer bed in the Custer Mine (0.043% germanium in ash with an ash percent of 16.64). Stadnichenko and his colleagues analyzed almost 1,000 coal samples from throughout the United States and concluded that concentrations of germanium were highest at the top and the base of coals. Looking at their data for North Dakota, it is difficult to discern a pattern with any degree of confidence because the majority of samples were below the analytical detection limit. However, germanium does not appear to be concentrated at the top of the four ND coals profiled in their study, but it is at the base of the Noonan and Custer coals mentioned above. Although the Stadnichenko study looked for, but did not find, a correlation between pyrite and germanium in coal, Hansen (1964) reported that germanium was concentrated within pyritic zones of North Dakota lignites. Hansen suggested that coal ash be researched to determine if germanium could be economically recovered from this potential resource. Unfortunately, more than 40 years later, it is still not possible to access the feasibility of such an endeavor because there is little to no published data on germanium concentrations for lignites being mined in North Dakota. The routine analyses required for coal, bottom ash, and fly ash do not include germanium.

Formation Resources, Inc. and PacMag Metals, Ltd.

As noted in the previous DMR newsletter (vol. 35, no. 2; June, 2008), Formation Resources, Inc. was issued two subsurface mineral permits in 2008 to explore for minerals in Billings and Slope counties. The initial focus of the company's exploration program was uranium and molybdenum-bearing lignites near the old Church or Fritz uranium mine in southeastern Billings County. As reported by the ND Geological Survey in 1964, the close association between molybdenum and uranium in uraniferous lignites of the Fort Union Group was well-established while uranium mining was taking place in southwestern North Dakota.

Formation Resources, Inc. is a wholly owned subsidiary of PacMag Metals, Ltd., licensed to do business in the state of North Dakota. PacMag Metals, Ltd. is an Australian company and holds the mineral leases on the Church property. The Australian government requires Australian mineral companies to report their findings via press releases as per the "Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserve." In compliance with these requirements, PacMag Metals issued seven press releases on the results of their exploration program in southwestern North Dakota between May 19 and November 5, 2008. These press releases are amazing in their geochemical detail. They include maps of the drill sites, tables of analytical results, and geologic cross-sections through the property. The DMR rules and regulations

Figure 1. Geologists collect lignite samples for germanium analysis from a hole drilled near the old Church or Fritz mine in southern Billings County.

require companies to submit all of the basic data (geologic logs, electric logs, analytical results, etc.) when the permit expires. This basic data can be held in confidential status for a period of one year following the end of the permit. Mineral companies routinely request this one-year period of confidentiality because they do not want competing mineral companies or speculators to see the results of their exploration any sooner than is absolutely necessary. Under normal circumstances, we would not receive the basic data from Formation Resources until June or July of 2009 and could not publically release it until May 17, 2010. Since none of the information in the press releases has yet been submitted to our office as basic data, it is not considered confidential and may therefore be discussed in this article.

Exploration and uranium mining in southwestern North Dakota in the 1960s determined that trace metals, including uranium and molybdenum, were concentrated in the upper portions of lignite beds. Exploration by PacMag Metals has confirmed the concentration of these metals in the top few feet of shallow lignites. The company has reported finding uranium oxide concentrations up to 0.43% and molybdenum oxide up to 0.19% in the upper parts of coals that are less than 11 feet below the surface. As previously noted, germanium is not one of the elements in a typical analytical suite. However, PacMag Metals tested for germanium knowing that both the USGS and the ND Geological Survey had found it in North Dakota lignites. In their October 14, 2008 press release, PacMag Metals reported that germanium dioxide concentrations of lignites they had sampled ranged from 1 to 271 ppm. Results from a late-2008 drilling and sampling program should give the company a much better understanding for germanium variability within the lignites in the potential mine area (fig. 1). If the germanium concentrations are sufficiently high across the property and the company eventually proceeds to the mining phase, they will have to determine how to environmentally and economically remove uranium, molybdenum, and germanium from lignites at this site.

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