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Identification and Characterization of Fibrous Zeolites in Western North Dakota

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The naturally occurring, non-asbestos, fibrous zeolite mineral erionite is a concern due to its potential for causing pleural malignant mesothelioma (PMM) in humans (Baris et al., 1987). PMM is a rare cancer usually associated with exposure to fibrous asbestos minerals. Studies have shown that low-level environmental exposure to erionite-bearing altered volcanic bedrock may be the explanation for a high PMM rate in certain locations (Metintas et al., 1999). Epidemiologic studies suggest erionite could potentially be more active and more toxic than some forms of asbestos (Metintas et al., 1999).

The presence of erionite in North Dakota was reported by Forsman (1986) as occurring in the Killdeer Mountains (KDM), one of a number of buttes in western North Dakota. It was discovered in volcanic tuffs of the late Oligocene to early Miocene Arikaree Formation. Other formations throughout western North Dakota, South Dakota, and Montana have been recognized as erionite-bearing (Goodman and Pierson, 2010).

Due to the possible health risks associated with inhalation of the fibers, hazard mapping (Forsman, 2006) was undertaken by the North Dakota Department of Health (NDDoH), in cooperation with the North Dakota Geological Survey (NDGS) and the Environmental Protection Agency (EPA). These investigations led to gravel quarry restrictions, gravel use restrictions, dust control measures, and guidance plans to control and reduce the overall exposure by businesses and private landowners working in close proximity to the bedrock formations and/or gravel quarries which potentially contain erionite (NDDoH 2009).

For the study reported here, samples were collected from regions in ND where erionite is known or suspected to be present. A total of 37 rock and/or soil samples were taken from North and South Killdeer Mountains in Dunn County, West and East Rainy Buttes in Slope County, and White Butte, also in Slope County.

Sample preparation consisted of breaking down each sample and placing it in a water column to separate any zeolite fibers from larger size fractions. Suspended materials, including the zeolite fibers, were collected from the water column and vacuum filtered. All 37 filtered samples were analyzed using powder X-ray diffraction (XRD). Of those, the 8 which showed the strongest zeolite patterns were analyzed using scanning electron microscopy (SEM). Visual inspection of the samples was conducted (Fig. 1), as well as determination of a preliminary chemical composition of the suspected zeolite fibers using SEM/EDS. The remaining 29 samples, which did not show as strong XRD indications of erionite or offretite, were also scanned by SEM to identify any other potential zeolite containing samples. The SEM/EDS chemical composition data of fibers were plotted for comparison with data from Forsman (1986) and Passaglia et al. (1998) (Fig. 2).

The results of this study are consistent with those of Lowers and Meeker (2007), who analyzed fibers separated from ND soil and roadbed samples. SEM/EDS data plot in both regions of erionite and offretite. Ongoing and future work includes stratigraphic correlation, additional powder XRD and SEM analysis, and electron microprobe analysis.

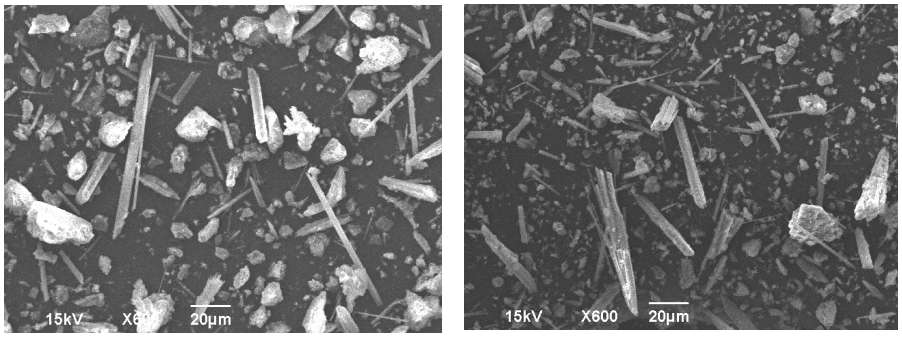

Figure 1: Concentrated zeolite fibers from South KDM. Left: sample jwt080602-01. Right: sample jwt080603-03

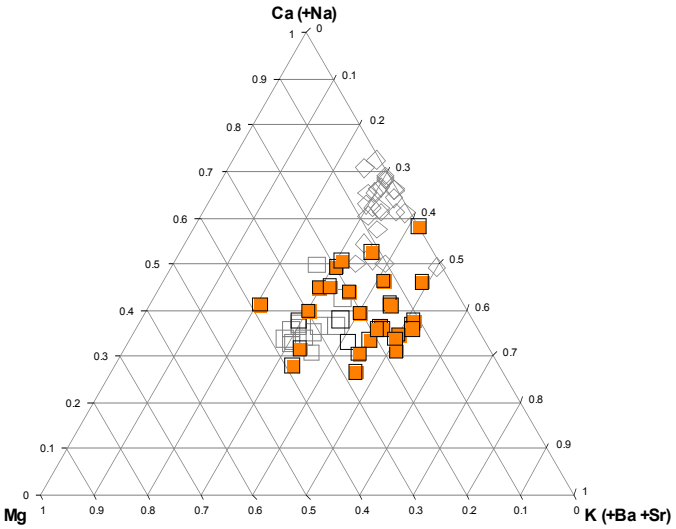

Figure 2: Comparison of SEM/EDS analyses. Passaglia et al. (1998): erionite (open diamond) and offretite (open box). Forsman (1986): erionite (bold, open box). This study: erionite/offretite (filled box).

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