ENVIRONMENTAL RISK ASSESSMENT FOR GYPSUM TELLS POSITIVE STORY

By Karen Bernick

Amending soils with flue gas desulfurization (FGD) gypsum offers a host of promising benefits to agriculture, and this beneficial use provides an opportunity for power plants to reduce disposal costs.

But is it safe?

The answer appears to be a resounding "yes" according to early reports from a comprehensive risk assessment by the U.S. Department of Agriculture (USDA) and U.S. Environmental Protection Agency (EPA). The assessment, likely to be concluded in 2013, addresses potential risks that land applications of FGD gypsum could pose to human health or the environment.

"USDA and EPA felt that a risk assessment would help states in their beneficial use designation process," says Rufus Chaney, a research agronomist at the USDA-Agricultural Research Service's Environmental Management and Byproduct Utilization Laboratory, in Beltsville, Maryland.

Beneficial use of non-hazardous materials, such as gypsum used for soil amendment, is regulated at the state level, explains Chaney, who is an expert in the study of trace elements, plant uptake, bioavailability, soil chemistry and toxicity. For the past 35 years he has performed intricate risk assessments for the use of biosolids in soils; remediation of toxic sites; cadmium, lead and arsenic trouble spots; and other contaminant risks in plant uptake and food. He is the lead USDA researcher on the FGD gypsum risk assessment.

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The USDA-EPA assessment examines what Chaney calls "new" FGD gypsum, a high quality form of synthetic gypsum sought by agricultural crop producers for its soil improvement benefits, calcium and sulfur supplies, purity and relative low cost versus mined gypsum. The same material is used for producing wallboard. It is a byproduct at coal-fueled power plants equipped with state-of-the-art emission scrubbing systems, and is created after fly ash removal. Forced oxidization is used to transform calcium sulfite into calcium sulfate dihydrate, a highly pure and consistent form of synthetic gypsum.

Chaney says "old" FGD gypsum was produced during fly ash removal and often had excessive residues of boron, arsenic and selenium. "These were a source of concern, depending on the coal source," he says.

But contaminants in the new material are at levels so low that Chaney and his team have found no evidence of any toxicity risks. "FGD gypsum is good stuff," he says. Chaney says the only risk he has identified occurs if livestock producers allow ruminants to eat large quantities of stockpiled gypsum. "If livestock producers prevent ruminants from eating gypsum by fencing in stockpiles, and limit grazing until after a rainfall to wash adhering FGD gypsum from forage leaves, the sulfate risk is prevented," he says.

RISK ASSESSMENT PROCEDURES

The USDA-EPA risk assessment evaluated an exhaustive list of possible pathways for contaminant exposure from applied FGD gypsum, including via:

- Farm and garden crops
- Soil ingestion by children, livestock and wildlife
- Livestock, wildlife and soil organism exposure to crops grown on amended soils
- Leaching and runoff from amended fields

Data were collected from a number of USDA-EPA collaborative FGD-gypsum field studies recently completed or currently underway in Alabama, Georgia and Mississippi, along with other data from

gypsum experiments sponsored by the Electric Power Research Institute (EPRI) in Ohio, Indiana, Wisconsin and North Dakota. Assessments were performed to identify and quantify any potential contaminants in soil, water, plant and gypsum soil amendments collected in the various experiments.

TRACE ELEMENTS

Soil scientists use milligrams (mg) per kilogram (kg), which is equal to parts per million, to describe the concentration of trace elements in soil. Elements are usually considered at trace levels if they are found at 100 ppm or less. In the FGD gypsum assessment, Chaney looked for trace element concentrations higher than corresponding concentrations in "background" or typical uncontaminated U.S. agricultural soils as documented by the U.S. Geological Survey and USDA.

If a trace element in FGD gypsum is lower than the level in background U.S. soils, Chaney says contamination problems have not been found. "No matter how hard we try, no matter how many 100 years we apply this quality of gypsum, we are not going to be able to build up the concentration level with the new FGD gypsum," Chaney says.

Chaney says the risk assessment has shown that FGD gypsum contains extremely low concentrations of most trace elements, about the same as found in mined gypsum and, in most cases, lower than background soils. [See Figure 1.]

SELENIUM

"With the exception of selenium and boron, trace elements in FGD gypsum are lower than the 95th percentile of US background soils," Chaney says.

Chaney notes that the selenium level in FGD gypsum is not able to cause risk because of the high levels of calcium sulfate which comprise gypsum. "Selenate in FGD gypsum is in a matrix of calcium sulfate, and the sulfate inhibits uptake of selenate by plants," Chaney says. "There is no evidence to suggest it would be a toxic factor to humans, livestock, or wildlife or have any adverse route from plants growing on amended soils." This selenate would be a low-grade fertilizer and improve the nutritional quality of forages grown on FGDG amended soils, Chaney adds.

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ARSENIC

Arsenic levels in FGD gypsum are lower than 95 percent of US background soils (10.1 vs. 12 mg/kg) but Chaney says there is a debate within the EPA about the appropriate limit for arsenic in soils.

"Toxicologists at EPA have calculated that the limit for soil arsenic should be 0.43 mg/kg soil based on cancer risk," explains Chaney. Recently they have proposed to reduce this 17-fold lower, which would be 0.025 mg As/kg soil, about 1/20th of normal soil arsenic concentration, according to Chaney. The proposed increase to the arsenic cancer slope factor is for one in a million chance of lifetime (70 years) risk for several cancers in humans with high arsenic exposures from contaminated drinking water.

The present 0.43 limit suggests that nearly all soils would be deemed toxic, Chaney says. "That number is below the 1st percentile of US natural soil – average US soil arsenic is 5 ppm," he explains. "We have found no evidence that this level of natural soil arsenic actually comprises risk to humans or the environment."

OTHER TRACE ELEMENTS

Boron is slightly higher in concentration for FGD gypsum than background soils but no cause for alarm, says Chaney. At typical fertilizer application rates, FGD gypsum supplies no more boron than a farmer would typically add if he or she were adding it as fertilizer. Further, boron does not accumulate in soils over time, and boron fertilizers are periodically applied for many crops (alfalfa, vegetables, etc.).

Mercury is another trace element that is sometimes associated with Coal Combustion Products, but Chaney says most of the mercury goes into fly ash and not the gypsum. Some FGD gypsum has slight elevations of mercury above typical background soils and mined gypsum, but Chaney says no risk has been identified. He explains that soil is a natural "sink" for aerosol mercury meaning soils and plants may emit mercury during the day but collect mercury at night; emissions vary by season (loss in summer but accumulation in winter) so it is difficult to identify a risk from the small amount added by gypsum over long periods of beneficial use applications.

Chaney says the many positive benefits of using FGD gypsum on cropland, combined with the lack of risks to human health or the environment, spells a very positive story for beneficial reuse in agriculture. ❖

Trace Elements in NEW Gypsum and Soils		
Element	FDG-G-95%ile	95%ile-US Soil
As	10.1*	12.
B	146.	.
Cd	0.29	0.6
Co	<2.0	17.6
Cr	8.69	70.
Cu	2.52	30.1
Mo	2.48	2.16
Ni	2.39	37.5
Pb	1.0	38.0
Se	27.9	1.0
Zn	15.0	103.

*Midwest Soil Improvement Symposium, August 23, 2011. EPRI data analyzed by Dayton at Ohio State University. USGS soil data (right column) published by: Smith, D.B., W.F. Cannon, L.G. Woodruff, R.G. Garrett, R. K. Klassen, J.E. Kilburn, J.D. Horton, H.D. King, M.B. Goldhaber and J.M. Morrison. 2005. Major- and trace-element concentrations in soils from two continental-scale transects of the United States and Canada. USGS Open-File Report 2005-1253.]

Figure 1 – Trace Elements in "New" Gypsum and Soils

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