Common soil mineral degrades the nearly indestructible prion

January 14 2009, by Terry Devitt

(PhysOrg.com) -- In the rogues' gallery of microscopic infectious agents, the prion is the toughest hombre in town.

Warped pathogens that lack both DNA and RNA, prions are believed to cause such fatal brain ailments as chronic wasting disease (CWD) in deer and moose, mad cow disease in cattle, scrapie in sheep and Creutzfeldt-Jakob disease in humans. In addition to being perhaps the weirdest infectious agent know to science, the prion is also the most durable. It resists almost every method of destruction from fire and ionizing radiation to chemical disinfectants and autoclaving, which reduce prion infectivity but fail to completely eliminate it.

Now, however, a team of Wisconsin researchers has found that a common soil mineral, an oxidized from of manganese known as birnessite, can penetrate the prion's armor and degrade the protein.

The new finding, which was reported earlier this month (Jan. 2) in the *Journal of General Virology*, is important because it may yield ways to decontaminate soil and other environments where prions reside.

"Prions are resistant to many of the conventional means of inactivating pathogens," says Joel Pedersen, a UW-Madison environmental chemist and the senior author of the new study. For example, autoclaving, a standard method for sterilization in the laboratory, will reduce the concentration of prions in solution, but fails to eliminate them altogether, as it does for virtually all other types of pathogens.

Because prions infect both wild and domesticated animals, the agent can contaminate barnyards and other areas where infected livestock are kept, as well as persist in natural environments where deer, elk and other animals can become infected by contact with contaminated soil.

Other studies have shown that prions can survive in the soil for at least three years, and that soil is a plausible route of transmission for some animals, Pedersen says. "We know that environmental contamination occurs in deer and sheep at least," he notes.

Prion reservoirs in the soil, Pedersen explains, are likely critical links in the chain of infection because the agent does not appear to depend on vectors — intermediate organisms like mosquitoes or ticks — to spread from animal to animal.

That the birnessite family of minerals possessed the capacity to degrade prions was a surprise, Pedersen says. Manganese oxides like birnessite are commonly used in such things as batteries and are among the most potent oxidants occurring naturally in soils, capable of chemically transforming a substance by adding oxygen atoms and stripping away electrons. The mineral is most abundant in soils that are seasonally waterlogged or poorly drained.

"A variety of manganese oxide minerals exist and one of the most common is birnessite. They are common in the sense that you find them in many soils, but in low concentrations," says Pedersen. "They are among the strongest oxidants in soil."

The new study, which was led by Fabio Russo of the University of Naples and Christopher J. Johnson of UW-Madison, was conducted on prions in solution in the laboratory. The group's working hypothesis, according to Pedersen, is that the mineral oxidizes the prion, a chemical process that can be seen in things like iron oxidizing to form rust or how

cut pears and apples turn brown when exposed to oxygen.

The next step, Pedersen says, is to mix the mineral with contaminated soil to see if it has the same effect. If it does, birnessite may become a useful tool for cleaning up contaminated farmyards and other places where the prion may be concentrated in the soil.

"I expect that its efficacy would be somewhat diminished in soil," says Pedersen. "It's something we'll explore."

Provided by UW-Madison