The Anatomy of an Antibacterial Clay Deposit

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The rapid rise of antibiotic resistant bacteria is seriously threatening our ability to treat life-threatening infections. As a result, our approach to medicine and agriculture will require significant changes if we are to successfully maintain current levels of healthcare and food security. A resurgence of inquiry into alternative antibacterial mechanisms has emerged as human pathogens have evolved antibiotic resistance. Certain naturally occurring clays have been shown to harbor antimicrobial properties and kill antibiotic resistant bacteria. These clays have been proposed as a new paradigm for fighting the potentially devastating effects of the post antibiotic era. Our research on the first antibacterial clay deposit in the U.S. (near Crater Lake, Oregon) provided a basic understanding of the role minerals can play in killing antibiotic resistant pathogens. One of the key components in the natural antibacterial clays is their ability to release soluble metals. These natural antibacterial minerals (Fe-sulfides and smectite) work by buffering solution pH (4-5) and redox potential (> 600mV) and maintaining hydration, while providing extended release of μM concentrations of Fe^{2+}, Fe^{3+}, Al^{3+} and reactive oxygen species (ROS). Metal solutions (Fe^{2+}, Fe^{3+} and Al^{3+}) which are not buffered by clays require higher (mM) metal concentrations to reach bactericidal levels. Understanding the geochemical and mineralogical processes that regulate the antibacterial activity of natural clays will help to usher in the medical application of new mineral-based antimicrobials.