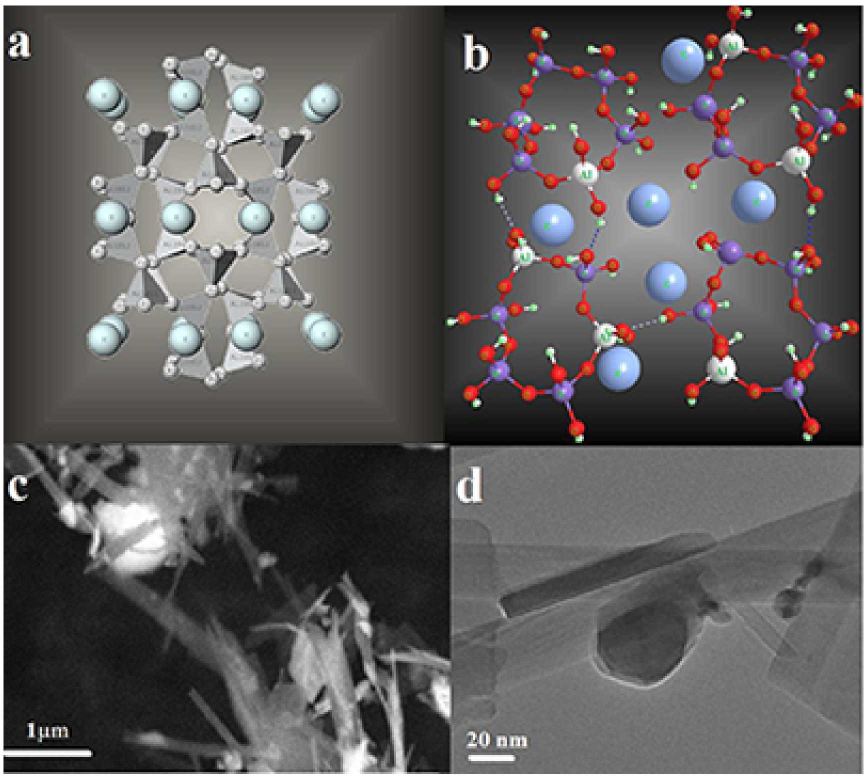
A new source for potassium fertilizer

April 10 2014, by Denis Paiste



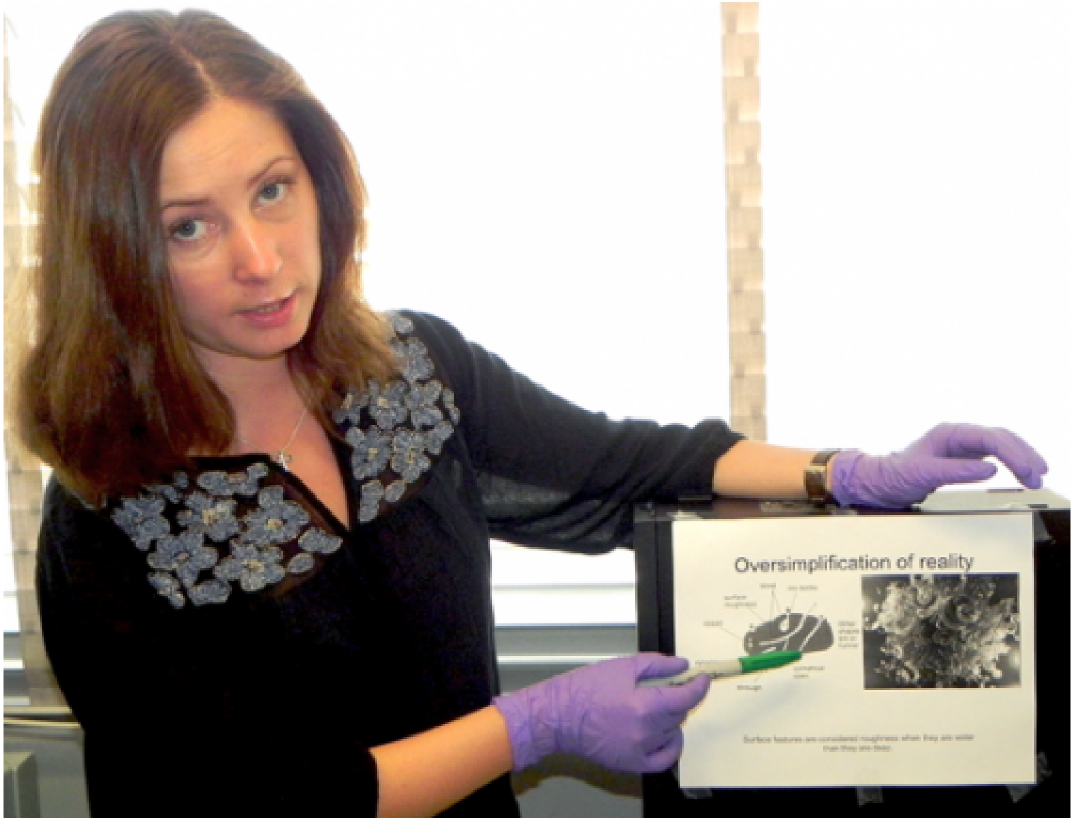
A schematic representation of crystalline structure in original feldspar microcline (top left) and one of amorphous component of the reconstituted material showing a semi-crystalline aluminosilicate matrix (top right) (with water molecules and OH groups are omitted for clarity); a scanning electron microscope image (bottom left) and transmission electron microscope image (bottom right) show co-existence of crystalline and amorphous components. Credit: Taisiya Skorina

Potassium-rich bananas are often grown in the Southern Hemisphere, in countries like Brazil, but farming banana trees requires potassium fertilizer obtained from mining potash in the Northern Hemisphere. That makes a country such as Brazil dependent on imports for 90 percent of its potassium. India, meanwhile, is 100 percent dependent on such imports.

Antoine Allanore, the Thomas B. King Assistant Professor of Metallurgy at MIT, is leading a research effort with globally important implications to produce potassium fertilizer from feldspar, a rock abundant in places like Brazil but which naturally releases potassium at too slow a rate for commercial farming.

The Canadian province of Saskatchewan is the world's second largest potash producer, with annual revenues of about $5.3 billion, according to recent research report from Rockstone Research Ltd. Growing world population and rising corn and wheat consumption for animal feed—mainly from the nations of China, India, and Brazil—drove potash demand up by 83 percent since 1970 to about 62.8 million tons in 2012. Last year, China's largest state-owned fertilizer producer, China Blue Chemical, made an investment in Vancouver-based Western Potash Corp. that will guarantee it a supply of potash for 20 years.

MIT research, funded by Brazilian mining company Terrativa, may have a solution, beginning with Brazil. The research funds are managed through the Materials Processing Center. In the Allanore lab, several Postdoctoral Associates are exploring different aspects of producing potassium from feldspar.



MIT postdoc associate Taisiya Skorina explains how surface roughness, a combination of pores and cavities in particles of finely ground feldspar, helps promote release potassium for fertilizer. She has developed a process to chemically alter feldspar to produce a new compound – coined "hydrosyenite" – with a popcorn-like texture. Credit: Denis Paiste/Materials Processing

- Taisiya Skorina has developed a process based on crushing and chemically altering feldspar to produce a new compound – coined "hydrosyenite" – with a popcorn-like texture in which potassium is contained in water-rich layers that make it more readily available. The chemical process is based on an alkaline treatment that does not lead to waste generation, a critical criteria for sustainable processes.
- David Ciceri is using microfluidic techniques to study how

potassium leaches from feldspar under exposure to acidic solutions. Ciceri is in the process of writing a review article, which will include a historical perspective, of the potash problem.

"We work with a rock which contains 15 percent potash," Allanore says. "Now we know what we need to do to control the rate of dissolution, and the amount of the original potassium you can gain access to, in a given amount of time; we have actually been very successful." Allanore and colleagues have secured a provisional patent, which he will describe in detail once the patent is converted. Skorina will be a co-author their paper. Allanore and Ciceri plan to present their potassium feldspar research at the World Soil Science Congress in Korea June 8-13, 2014.

A field study is underway in Brazil to see how plants such as sugar cane and oranges react to the new potassium material. Field studies are needed because laboratory studies don't replicate natural conditions, where release of potassium into the soil and its uptake by plants are affected by bacteria, fungi, and other other soil materials. "It's a pretty intricate system, where we don't have a benchtop experiment to replicate that," Allanore says. Microfluidic devices may be better able to mimic actual field conditions.

MIT postdoc associate Davide Ciceri with microscope that can analyze thin-sections of samples of processed feldspar using both reflected and transmitted light. Credit: Denis Paiste/Materials Processing

"It was pretty significant funding, and we've accomplished both goals. One was to develop a process to make the material perform better, in a controlled manner, and at the same time we are developing the tools that can allow someone to validate the performance of the material in more real conditions," Allanore says. "This is extremely exciting for us because we've been doing a lot of work on that, and finally our results have a direct impact."

The new material could also reduce waste in agricultural fertilizers because farmers typically only get the benefit of about three-quarters of the potassium fertilizer they apply. About 30 percent is lost to run-off from rainfall and other factors, so farmers need to apply 30 percent extra. Another potential benefit is eliminating the harmful salt build up that can be caused by potassium chloride-based fertilizer from potash because in feldspar-based fertilizer, potassium is released from silicon and oxygen compounds and doesn't include chloride.

More information: The report titled "Primed to Build a World-Class Potash Mine" is available online: www.rockstone-research.de/rese … 19FEB2014english.pdf

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