

## NRRI Mission:

Deliver research solutions to balance our economy, resources and environment for resilient communities.

[www.nrri.umn.edu](http://www.nrri.umn.edu)



## From the Editor:

Funny man Milton Berle once said "If opportunity doesn't knock, build a door."

That is what NRRI does. We build doors of opportunity for Minnesota to keep wealth in the state and use our resources wisely.

Thanks to the vote of confidence from our stakeholders and legislators, NRRI received much needed additional and annually recurring funding of \$2 million.

This infusion allows our hard-working researchers to deliver applied research at the highest standards and will attract top talent to anticipate future challenges. Minnesota deserves nothing less.

## June Breneman



NRRI is proud to be a partner with Better Futures Minnesota which received the Environmental Initiative's Sustainable Business Award last month.

NRRI's role is to help this social enterprise get the highest value from the materials they pull from deconstructed houses. The organization gives job skills and a good paycheck to men with employment barriers.

## NRRI Leadership

Rolf Weberg, Executive Director

## Initiative Directors:

Don Fosnacht, Renewable Energy  
Elaine Hansen, Business & Entrepreneurial Support

George Host, Forest & Land  
George Hudak, Mining, Minerals & Metallurgy

Lucinda Johnson, Water  
Eric Singaas, Wood & Bioeconomy

Duluth Labs & Administration  
5013 Miller Trunk Highway  
Duluth, Minn., 55811  
218-788-2694

Iron Range Labs  
One Gayley Avenue  
Coleraine, Minn., 55722  
218-667-4201

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## Minnesota Value: Study shows state has titanium resources

NRRI announced in May the completion of a technical report that shows pilot-scale success at producing titanium dioxide from an ilmenite deposit near Hoyt Lakes.

It's long been known that among Northeastern Minnesota's rich mineral mix are deposits of ilmenite. This is the mineral from which we get titanium dioxide, used in hundreds of daily use products, and eventually for titanium metal. The challenge with commercializing the resource has been the magnesium oxide impurities that couldn't be removed with conventional processing.

NRRI partnered with Process Research Ortech (PRO) to demonstrate a proprietary hydrometallurgical process to produce nearly pure titanium dioxide concentrate with high market value. Currently, titanium dioxide's market value is approximately \$3,200 per metric ton. For comparison, the market value of Iron Range taconite pellets is about \$70 ton.

NRRI tested a 10-ton sample of rock from a deposit called "Longnose" owned by American Shield Titanium Group LLC. It is the largest and richest ilmenite deposit in the United States. This particular deposit also has low overburden, a confined mining footprint and low sulfur content.

"As a trained geologist, I've known about the ilmenite there for 30 years," said company President Bill Ulland. "This process demonstrated by NRRI and PRO appears to be very cost effective with commercial potential. There's a very strong market now for titanium dioxide."

The separation process recovered an estimated 64 percent of ilmenite as concentrate. The following PRO technology targeted removal of iron and titanium oxides. After two scale-up processes, NRRI



NRRI Executive Director Rolf Weberg (right) answers questions at a press conference to announce the study results. He is joined by researchers Matt Mlinar and George Hudak.

and PRO were able to achieve titanium purity of 99.8 percent. Pure iron oxides were also separated at 98.5 percent (unoptimized) purity and could add to the market value of the deposit.

"This is especially exciting because we have an opportunity to process the ilmenite to an end product, titanium dioxide, here in Minnesota," said NRRI Executive Director Rolf Weberg. "NRRI's role is to define the state's portfolio of mineral opportunities. That is how we retain wealth, add value to our resources and take care of our environment."

A preliminary marketing study by UMD's Center for Economic Development found that there are few U.S. producers of titanium dioxide and many consumers for a wide variety of

applications – especially in paints and coatings, plastics and paper. With further processing, titanium dioxide can also be used for titanium metal production and niche products, like electronics and energy storage. NRRI intends to seek further funding to pursue additional geological, metallurgical and environmental studies. One goal is to optimize the hydromet process for iron and titanium, and to understand the feasibility of isolating other high value materials.

This project was funded by the Iron Range Resources and Rehabilitation Board, the UMD's Vice Chancellor for Academic Affairs and the University of Minnesota Office of the Vice President for Research.

## Innovative Research: New tools for new views into old industries

From birds-eye views to seeing deep into the earth, new technologies are providing old industries with accurate data previously approached with an educated guess, albeit well-educated.

Gathering amazingly precise and efficient data is now possible with drone (Unmanned Aerial Vehicles or UAVs, in polite circles) and LiDAR (Light Detection and Ranging) technologies. And NRRI is helping to expand their use to Minnesota's legacy industries – mining, forestry and forest products – as well as wetlands, wildlife and invasive species management.

### From Up Above

It soars over the treetops so raptor-like that threatened birds of prey go on the attack. The black, winged UAV, controlled from the ground by NRRI Researcher Paul Meysembourg, digitally photographs a forest plot near Duluth to gather data on tree height. From the images, NRRI Forestry Specialist Dan Buchman can estimate tree age and density to predict timber volume.

"We already have lots of data that we've collected over the decades from other projects," said Buchman. "With our understanding of tree growth – especially aspen and red pine – and the accuracy of the data we get with the UAVs, these are powerful tools."

The idea of applying multi-spectral cameras to flying craft came out of the agricultural industry. The special cameras capture images in special shades – green, infrared, near-infrared and red-edge – that are reflected by changing colors in plants. Farmers can see over thousands of acres where their crops are failing.

For forest applications, resource managers can see where there's water stress, insect invasions or nutrient deficiencies. The most obvious use allows foresters to quickly and inexpensively track tree growth and monitor



NRRI researcher Paul Meysembourg prepares a UAV (Unmanned Aerial Vehicle) for take-off. It will capture images of a forest plot for analysis by NRRI forestry expert Dan Buchman.

harvests. NRRI is also considering applications like watching for where biomass should be harvested to reduce fire hazards, and forest fragmentation problems for wildlife.

"We can zip over to a plot, gather the information in an afternoon and have it ready to analyze the next day or two," said George Host, NRRI Forest and Land Initiative Director. He also wants to expand use of the camera-laden UAV to mining operations and to monitor tailings stockpiles and calculate their volume.

### From Down Below

After the Minnesota Legislature funded high-resolution elevation LiDAR scanning of the whole state, top to bottom, Dean Peterson saw an opportunity. He could use that free data to "see" in three dimensions where bedrock is exposed on the surface and where mineral core holes were drilled. Exactly.

"It's just incredible," said Peterson, NRRI senior geologist. "With the surface accurately mapped and the unseen depths geologically modeled, we are on the cusp of a more robust understanding of Minnesota's geology and ore deposits."

At his desk using the NRRI's GOCAD® 3D geological software, Peterson points out

the glacial landforms, noting how the glaciers moved across the landscape. He zooms in on the Iron Range, the Laurentian Divide and old, turn-of-the-century mining sites.

For new mining opportunities, it allows for a thorough examination of the geology and mineralization exposed on the surface and at depth without sticking a shovel into the ground. With an accurate understanding of the valuable mineral mix and potentially harmful byproducts, a better plan can be presented for permitting. Environmental impacts can be reduced with more targeted mining for the highest value ores.

"When I first started in geology, we had no GPS," Peterson reflected. "We'd spend at least a third of our time just figuring out where we were in the woods. And when you were standing on magnetic iron formation, the compass would be useless, of course!"

Today's geologists know exactly where they are with GPS, where the minerals could be exposed with LiDAR and 3D software to visualize unseen geology and mineral deposits.

NRRI will apply its multi-disciplinary approach to expanding the uses of these tools even further. The added accuracy and efficiency will take industries and data-gathering to new heights. And new depths.