

Geosciences and Engineering

Southwest Research Institute's geosciences and engineering specialists continue solving nuclear, petroleum, planetary science, and groundwater problems for government and industry, using diverse laboratory, field, and computational approaches. In particular, SwRI offers world-class technical expertise in high-level radioactive waste management, providing important resources as the nuclear energy sector undergoes a renaissance.

This year, the Nuclear Regulatory Commission renewed its contract for another five years, authorizing SwRI to continue operating the Center for Nuclear Waste Regulatory Analyses (cnwraweb.swri.org). Under the nearly \$125-million-dollar contract, the CNWRA® will continue more than two decades of technical assistance to the NRC staff, conducting risk assessments and pre-licensing and licensing reviews for a potential high-level radioactive waste geologic repository at Yucca Mountain, Nev.

The backbone of the risk assessments is the Total-system Performance Assessment code developed by SwRI and NRC. This comprehensive, integrated tool provides risk insights into



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Using internal funding, SwRI staff members are developing a wireless-sensor-based system to map and characterize water-filled cave passages using neutrally buoyant wireless sensors. Drifting through the passages and using internal propulsion systems to navigate around obstacles, the sensors autonomously map the pathway, flow velocity and dimensions of these important groundwater conduits to improve management of karst aquifers.

the many diverse processes that could affect waste containment for up to a million years after disposal. These insights, in turn, increase understanding of how the potential release of radioactive constituents could affect public health and safety and the environment. Using TPA Version 5.1, the staff evaluated risk-important features, events and processes associated with the proposed Yucca Mountain repository.

We continued to assess the performance of engineered barriers, such as nickel alloy waste packages and titanium drip shields, and natural barriers, including the hydrologic and geochemical properties of the rocks and soils surrounding the underground rock vaults. We also assessed the paths radioactive constituents would follow if released from the potential repository. We conducted experiments to evaluate the mechanical properties of drip shields and waste packages and performed numerical analyses to

assess interactions between drip shields and the surrounding rock mass. In addition, we assessed potential vulnerabilities of the repository to natural and human-induced risks, such as earthquakes or aircraft impacts.



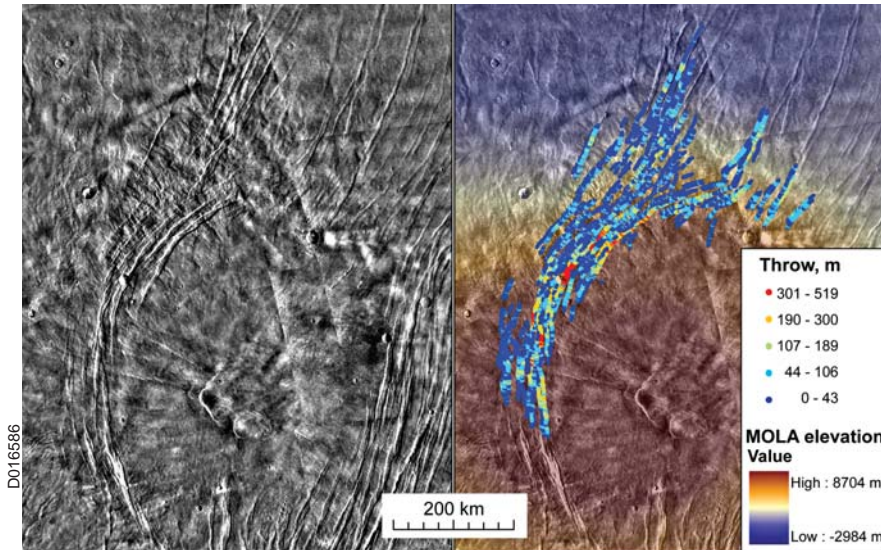
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In a research collaboration with ConocoPhillips Subsurface Technology, SwRI geoscientists are using three-dimensional geomechanical models to gain insight into the temporal and spatial evolution of fractures in a geological fold in Wyoming that serves as a subsurface analog for oil and gas reservoirs around the world. The geomechanical model predicts areas of high strain (hot colors) that correlate with intensely fractured sandstone outcrops of the Cretaceous Frontier Formation.

geophysical & geological investigations • groundwater resource evaluation • geological structure analysis
 energy exploration • chemical & radiological contaminant transport • laboratory, field & numerical analyses
 corrosion & materials life prediction • risk & performance assessment • environmental impact assessments
 geoscience processes • structural integrity analyses • reliability & operational safety analysis
 planetary science • regulatory analysis & guidance

Courtesy NASA



SwRI is analyzing faults on the western and northwestern flanks of the Mars volcano Alba Patera. Combining the volcano image acquired by the Viking spacecraft with elevation data from the Mars Orbiter Laser Altimeter, the bright colors indicate the vertical displacements of these faults.

We continued investigations into general and localized corrosion of the waste package materials and studied low-temperature creep deformation of the alloy at the microstructure level (corrosion.swri.org).

Also included in the TPA code are improved methods for estimating net water infiltration based on climates that may evolve over the next million years. We also developed BDOSE™, a biosphere dose assessment model that uses probabilistic analysis to assess the effects of radiation on public health and safety.

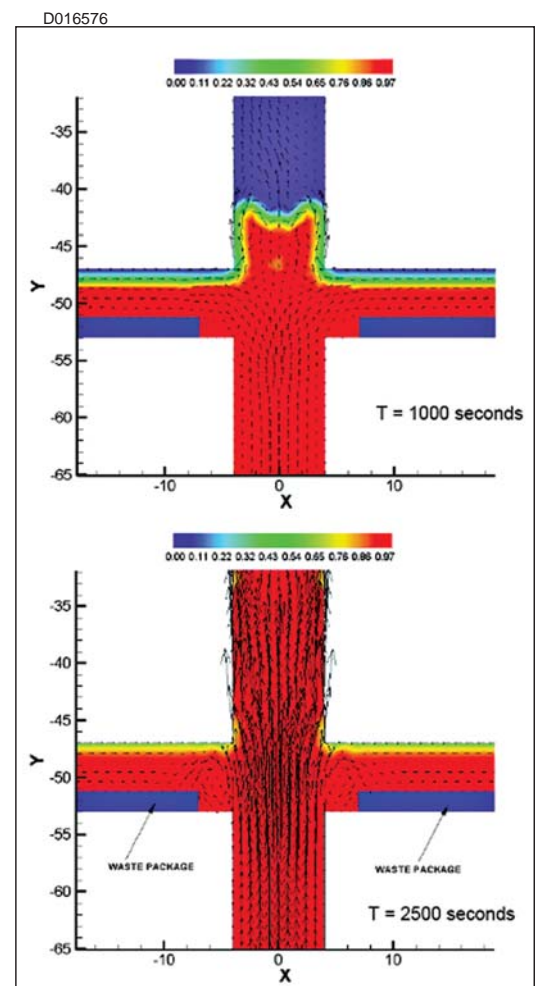
Internationally, our staff continued radionuclide transport simulations and support for a repository site license application for the Swedish Nuclear Fuel and Waste Management Company. We also completed the second phase of geologic and hydrologic modeling for the Horonobe Underground Research Laboratory in Hokkaido, Japan.

Expanding work for the oil and gas industry included geomechanical and stress-state modeling of petroleum reservoirs in Colorado, Wyoming, the North Sea, Indonesia and South America (geoscience.swri.org). SwRI completed the first year of a multiyear joint industry project aimed at advancing knowledge about how faulting in carbonate strata affects oil and gas production (carbonatefaultproject.swri.org). We also are initiating two new structural geology training courses for the oil industry.

Continuing work in water resource analysis included studies of surface and groundwater in Mexico and water-related environmental issues in Wyoming as well as ongoing investigations of the karst aquifer systems of south-central Texas (karst.swri.org).

Taking our geological expertise to other worlds, we are investigating faulting, pit chain formation and volcanic-tectonic interactions on Mars. We continued developing the MarsFlo code to model hydrological processes below the surface of the Red Planet. Using our physical analog facilities, we are investigating tectonic resurfacing processes on Jupiter's largest moon, Ganymede, and modeling pit chain formation on the near-Earth asteroid Eros (planetarygeosciences.swri.org). ❖

Visit geosciences-engineering.swri.org for more information or contact Vice President Dr. Wesley Patrick at (210) 522-5158 or wesley.patrick@swri.org.



The CNWRA staff improved hazards assessments associated with potential future volcanic intrusion and eruption in the Yucca Mountain region, applying numerical models and studying the eruption dynamics and phases of an analog volcano. This computational fluid dynamics model illustrates the time sequence of a basaltic magma filling an underground storage tunnel where radioactive waste packages would be placed.