# RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals



## Tracking a Jurassic reversal of the Earth's magnetic field

Roughly 180 million years ago, during the height of the Jurassic period, the Earth's magnetic field flipped, bringing the magnetic north pole once again into the Northern Hemisphere. This so-called van Zijl reversal, named for the researcher who first described it, is the second-oldest well-documented geomagnetic reversal. Such perturbations of the Earth's magnetic field, which tend to take place over about 10,000 years but possibly much less, have been identified as occurring up to several billion years ago and as recently as 780,000 years ago. An open question exists about the effect of such reversals on the properties of the Earth's magnetic field, including the structure it takes, and the consequent effects on its shape, size, and strength. Drawing on newly identified records of the van Zijl reversal, *Moulin et al.* describe the serpentine travels of the transitional magnetic pole and the variable strength of the paleomagnetic field.

Analyzing the orientations of magnetic minerals found encased within rock samples drawn from an ancient lava field in Lesotho, a small country encompassed within South Africa, and from another field in South Africa itself, the authors tracked the shifting geographic location of the ancient magnetic pole. They

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*From rock samples in the Karoo large igneous province in southern Africa, scientists mapped a 180-million-year-old reversal of the Earth's magnetic field.*

found that over a short period, possibly only a few centuries, the pole leapt from a location oriented around 45°S to one near 45°N. The paleomagnetic pole then drifted through around 20° latitude as it moved to the southeast. Finally, the pole moved to a stable location centered near the geographic north pole. The authors found that leading up to the magnetic reversal, the strength of the magnetic field weakened to roughly 10%–20% of its normal value, a depression that only decayed once the pole's location stabilized. (*Geochemistry, Geophysics, Geosystems*, doi:10.1029/2011GC003910, 2012) —CS

## Declining sea ice to lead to cloudier Arctic

Arctic sea ice has been declining over the past several decades as global climate has warmed. Moreover, sea ice has declined more quickly than many models predicted, indicating that climate models may not be correctly representing some processes controlling sea ice.

One source of uncertainty in models is feedback from cloud cover. Sea ice can affect cloud cover, as melting sea ice and increased evaporation from the ocean surface can lead to increased cloud formation. In the Arctic, clouds have an overall warming effect on the surface, so greater cloudiness in this region could lead to even more sea ice melt.

*Liu et al.* analyzed satellite observations of cloud cover and sea ice from 2000 to 2010 to evaluate feedbacks between sea ice and cloud cover. They found that a 1% decrease in sea ice concentration leads to a 0.36–0.47% increase in cloud cover and that 22–34% of variance in cloud cover can be explained by changes in sea ice. So as sea ice declines, the researchers predict that the Arctic will become cloudier. (*Geophysical Research Letters*, doi:10.1029/2012GL051251, 2012) —EB

## Improving understanding of geomagnetic substorms

Substorms, the frequent, brief magnetic disturbances that originate in Earth's magnetotail, cause acceleration of particles in the magnetosphere and their precipitation into the ionosphere, resulting in sudden brightening and increased movement and expansion of aurorae. *Sergeev et al.* review recent progress that has been made in understanding the onset and dynamics

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of substorms. In particular, recent observations have confirmed that magnetic reconnection—the breaking up and rejoining of magnetic field lines and release of energy—in the Earth's magnetotail, which sends fast plasma streams into the inner magnetosphere, is closely associated with substorm onset. Large-scale reconfiguration of the magnetic fields in the magnetotail and local instabilities interact in complex ways, leading to the onset of substorms.

Although scientists do not yet have a complete understanding of substorms, the authors note that the combination of observations from a variety of operational satellites and planned missions, along with improved modeling capabilities, is likely to help scientists answer some of the open questions about substorm dynamics. (*Geophysical Research Letters*, doi:10.1029/2012GL050859, 2012) —EB

## A general approach to spontaneous imbibition

Spontaneous imbibition occurs in a porous medium when, driven by capillary forces, a wetting fluid such as water displaces a nonwetting fluid like oil or air. This is a common phenomenon, relevant to many processes such as groundwater contamination, steam migration in geothermal systems, carbon dioxide sequestration, and oil recovery.

Statistical physics indicates how the position of the leading edge of the water scales with time. However, although the phenomenon has been studied for more than 90 years, not even simple questions like the influence of viscosities on spontaneous imbibition were well understood. In fact, even the classic theoretical framework commonly used for describing spontaneous imbibition has been debated recently.

*Schmid and Geiger* derived a master equation for scaling groups used to rigorously characterize all key parameters in spontaneous imbibition. The result has practical and theoretical implications: First, it forms the missing piece for a multitude of models. Furthermore, the result suggests that the classical description of imbibition is satisfactory. (*Water Resources Research*, doi:10.1029/2011WR011566, 2012) —EB

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