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Earth & Space

Antarctica Has Got the Chilly Chilly Shakes

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ABSTRACT

Antarctica was once thought to have limited earthquakes. Local data exposed 27 earthquakes in just one year, showing that Antarctica does have earthquakes. These earthquakes outline an ancient rift system buried beneath more than a mile of ice.

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A well-known fictional captain once called space the final frontier, but here on earth there is one place in desperate need of further exploration. In some ways, we know more about the moon and Mars than we do Antarctica. New studies are being conducted every field season to try to unlock some of the many mysteries of the ice covered continent. Field work in Antarctica is quite challenging, it takes a lot of effort to get people and equipment to established bases and even more to reach unexplored regions. One such field project sought to understand the presence of a subglacial mountain range in East Antarctica called the Gamburtsev Subglacial Mountains, in part by installing seismometers over several field seasons.

For those of us who study earthquakes, Antarctica has long been a puzzle. At one time it was fairly accepted that the oldest parts of Antarctica (old and stable interior parts of the continent called 'cratons') did not experience appreciable earthquake activity. This idea was proposed thirty years ago and has only been successfully refuted recently. In our study we document 27 earthquakes that occurred in the East Antarctic interior during 2009. Our study is the first to use a network of locally installed instruments to detect earthquakes in Antarctica. Previously only earthquakes large enough to be recorded at a distance (mostly using instruments across oceans on other continents) were able to be reported. As we recorded 27 events in a single year, we propose that Antarctica does not experience a lesser amount of earthquake activity than other cratons.

A field team began installing seismometers in East Antarctic in 2007-2008 and finished in 2008-2009. In

our study we only attempted to locate earthquakes during 2009 when the entire 26 station array was operational. Earthquake detection and location requires all instruments to be recording at the same time and operational when the earthquake occurs. We found 27 earthquakes for 2009. We took steps to show that all 27 events are truly earthquakes that occurred in the Earth's crust and not so called 'icequakes' that would have been located in the ice sheet itself. We also take into account teleseismic events (events recorded by distant stations) that can be found in the published earthquake catalogs. We combined the events recorded by our array and the 8 teleseismic events to calculate the magnitude frequency relationship (called a *b*-value) for Antarctica. This relationship indicates how well a region fits the global pattern of seismicity. Globally we expect to see *b*-values of about 1, meaning for each earthquake of a given size we would expect ten earthquakes one size smaller. Stable cratons like Canada tend to have a *b*-value close to the global average. We found that Antarctica also has a *b*-value near to the global average, and in fact the difference between the values we calculate for East Antarctica and Canada are not statistically significant.

The earthquakes we found are not exciting just because of their presence but also where in East Antarctica they occur. Something odd is apparent when looking at the locations of the earthquakes. The earthquakes trend in a somewhat linear fashion. Satellite imagery gives no indication of why earthquakes might behave so: everything is flat ice. However, if we peak beneath the ice by looking at the actual bedrock elevations, we begin to see a very compelling story. The earthquakes do not occur in the crust beneath the Gamburtsev Subglacial Mountains themselves, but rather beneath adjacent low lying areas. A previous study by our colleagues using airborne radar identified these low lying regions as an ancient rift system. That our earthquakes occur here shows that while not active, these rifts are still areas of weakness, because nature will always take the path of least resistance.

Our study shows that Antarctica isn't that different from other continents seismically. We observe similar seismic behavior as we do in most other parts of the world. The more we learn about Antarctica, the more we find that while some things are quite unique to the ice covered continent, others are similar to the rest of the world. There are still many mysteries and frontiers to explore, parts of the interior have never been visited by anyone. Working in Antarctica is and always will be a challenge. However, it is vitally important to continuing asking questions and looking for answers for what is happening beneath the ice, because what happens beneath the ice has great effect on the ice itself and on our planet's future.