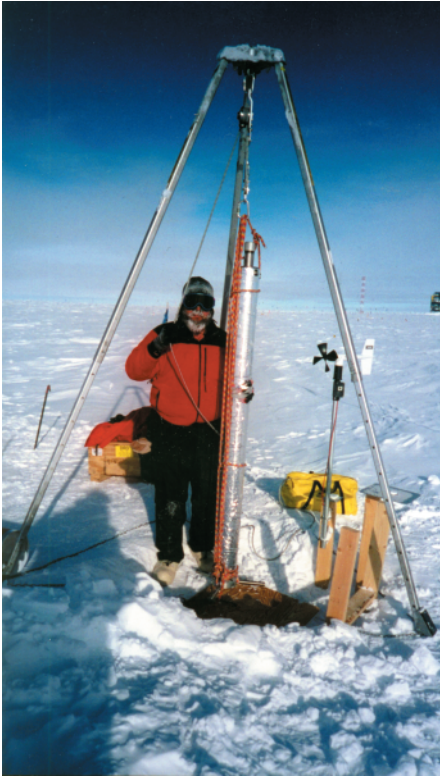




Seismology at the South Pole

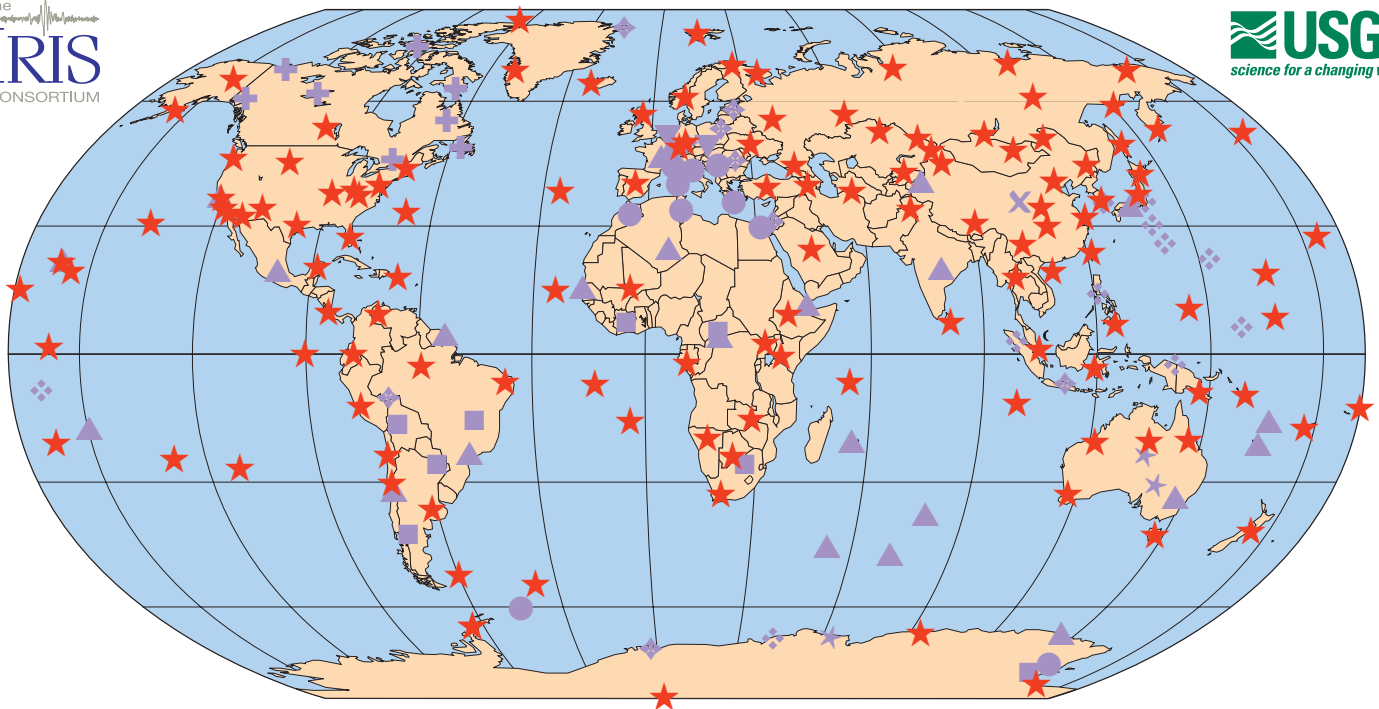


Kent Anderson from USGS/IRIS prepares to test a GSN borehole seismometer which will be installed at the new SPRESO seismic station.

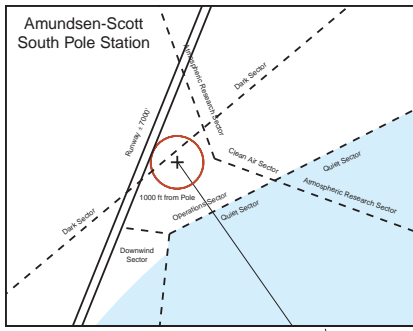
Seismology was the first scientific experiment at the South Pole during the International Geophysical Year 1957, and continues as the longest running observational science at the Pole. This year the current Global Seismographic Network (GSN) instrumentation—the fifth generation since IGY—is being upgraded, as the new South Pole Remote Earth Science Observatory (SPRESO) is being completed.

Seismology is inherently a global science. A world wide cooperative effort is required to monitor the Earth's seismicity. The seismic station at the South Pole is a key site in the GSN, funded by the U.S. National Science Foundation through the Incorporated Research Institution for Seismology (IRIS), and operated in partnership with the U.S. Geological Survey (USGS) through the Albuquerque Seismological Laboratory. This GSN station also serves as a United States contribution to the International Monitoring System for the nuclear Comprehensive Test Ban Treaty.

The South Pole has a unique vantage for seismology. Located on the Earth's axis of rotation, free oscillations of the Earth generated by great earthquakes and measured here are not effected by rotational forces felt elsewhere. Seismic energy felt as strong shaking at the source also travels down deep into the Earth all the way to the South Pole, where the GSN station has a window to the 'underside' of the earthquake, or a possible nuclear explosion. Seismology has discovered that the Earth's inner core—where seismic waves travel more swiftly along the rotational axis, and slower parallel to the equator—rotates slightly faster than the outer Earth. With most of the Southern hemisphere covered in ocean, the global coverage from Antarctica and the South Pole are crucial for unbiased studies of the Earth's three dimensional structure. Although Antarctica itself has few earthquakes, the South Pole station is the reference for all tectonic and structural studies of this continent and the southern oceans.



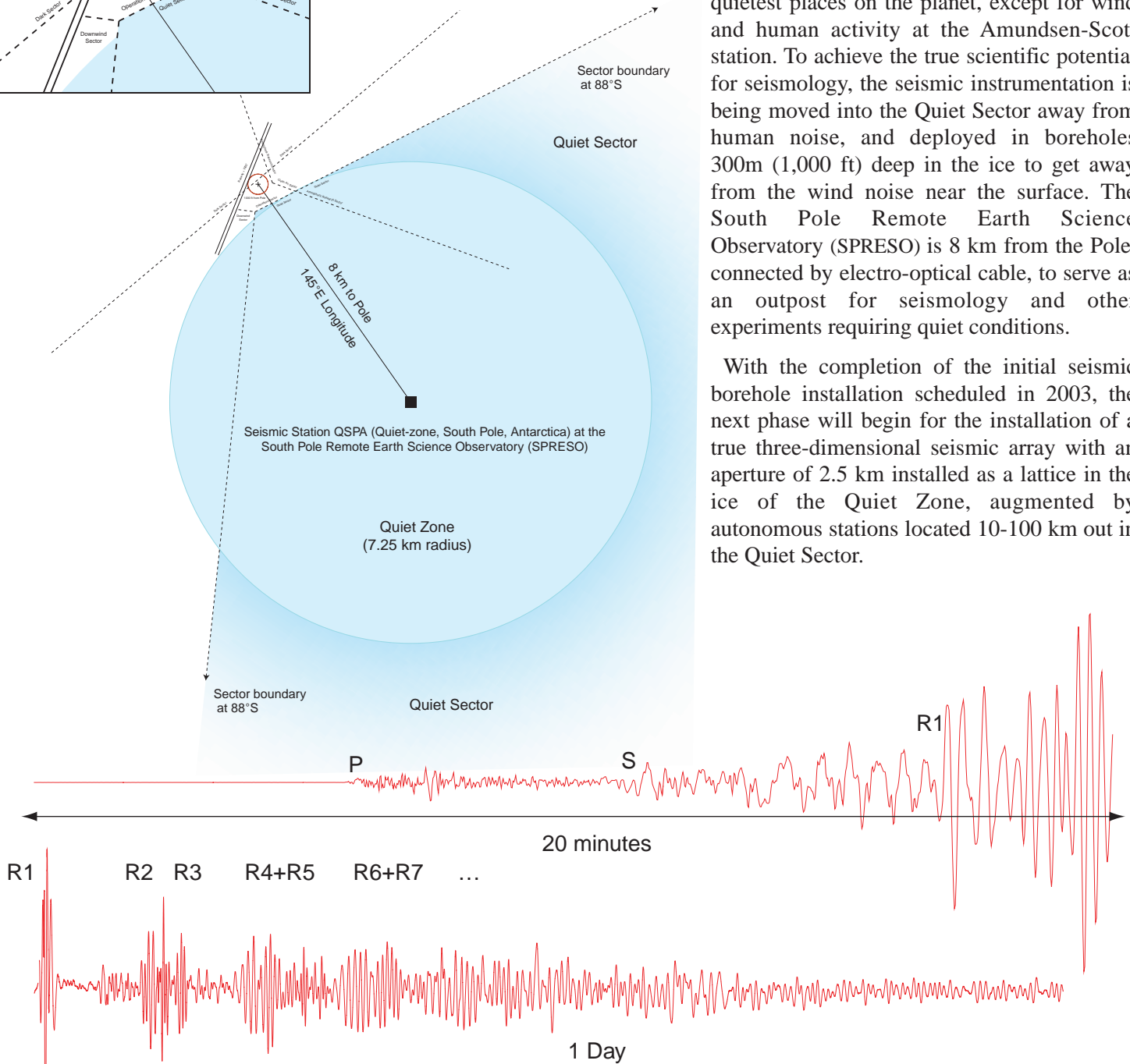
The seismic instrumentation at the South Pole is part of the Global Seismographic Network (red stars), which cooperates with other international networks (purple symbols), as a multi-use facility for seismic monitoring and geoscience research.



Grid North
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The South Pole is potentially one of the quietest places on the planet, except for wind and human activity at the Amundsen-Scott station. To achieve the true scientific potential for seismology, the seismic instrumentation is being moved into the Quiet Sector away from human noise, and deployed in boreholes 300m (1,000 ft) deep in the ice to get away from the wind noise near the surface. The South Pole Remote Earth Science Observatory (SPRESO) is 8 km from the Pole, connected by electro-optical cable, to serve as an outpost for seismology and other experiments requiring quiet conditions.

With the completion of the initial seismic borehole installation scheduled in 2003, the next phase will begin for the installation of a true three-dimensional seismic array with an aperture of 2.5 km installed as a lattice in the ice of the Quiet Zone, augmented by autonomous stations located 10-100 km out in the Quiet Sector.



The magnitude 8.1 Balleny Island Earthquake in 1998 was one of the world's largest in the last decade and occurred 3,000 km from the South Pole toward Australia. The traces show the vertical motions at the South Pole GSN seismic station. In the upper trace, the Primary (P) compressional waves arrive within about 6 minutes after traveling over 700 km deep in the Earth. They are followed along the same path by Secondary (S) waves that shake perpendicular to their propagation direction. The difference in time (S-P) is an measure of the distance to the earthquake. These waves that travel through the body of the Earth are followed by much larger Rayleigh waves (R) that travel near the surface. In the lower trace in the day following the earthquake surface and body waves continue to vibrate around the planet. The surface wave R2 travels the long arc to the South Pole, going first north over the North Pole. After R1 passes the South Pole, it continues around the world again, returning as R3. Similarly, R2 propagates around again as R4. This continues (R5, R6, R7,...) for days as the waves spread out and merge. The seismometers at the South Pole are capable of recording the largest earthquakes with full fidelity and at the same time the smallest vibrations of about 1-billionth of a meter.