

# First (1957-58) Geophysical Investigation of the Filchner-Ronne Ice Shelf

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**SUMMARY** The only major field project of the U.S. International Geophysical Year (IGY) Antarctic program was a series of oversnow traverses (Behrendt, 1998; 2003) mostly in West Antarctica, starting in 1957, making seismic reflection ice soundings (and other geophysical measurements) and glaciological measurements. The 1900-km Filchner Ice Shelf (FIS) oversnow traverse mapped snow surface elevation, ice thickness and bed topography of the Filchner-Ronne Ice Shelf (FRIS) area, as well as snow accumulation, the mean annual temperature of that era, and made a geological reconnaissance of the Dufek Massif. Results included the definition of the Thiel trough beneath the FIS and the maximum ice thickness of the southernmost area of the Ronne Ice Shelf (RIS) of 1300 m which is in contrast to 1100-m thickness remeasured by BAS for this area in 1994-95 of only 1100 m suggesting significant melting during the interval.

## **FILCHNER ICE SHELF TRAVERSE, 1957-58**

On 28 October, 1957, our five man party, co-led by Edward Thiel and Hugo Neuberg, left Ellsworth Station on the Filchner ice front with two Sno-Cats (in contrast to the usual three on the other US traverses) each pulling a 2.5-ton sled filled with fuel, food, explosives, (Fig.1) and all of our scientific and other equipment. For the next 81 days we made a geophysical-glaciological reconnaissance of the Filchner-Ronne Ice Shelf area.

The logistics of the traverse oversnow traverse program were dictated by the fact that state-of-the-art electronics at the time depended on the vacuum tube, rather than the solid-state electronic microcircuits available today. The hundreds of tubes in our seismic system required large amounts of battery power. The power requirements, in turn, required two 250 amp-hour batteries weighing 80 kg each to produce the 24 volts necessary for operation. The only recording system was the heavy oscillograph "camera" with its tanks of photographic solutions. Altogether the seismic Sno-Cat carried a total load of about 500 kg of electronic equipment, gravimeter, magnetometer, and seismic batteries. Each Sno-Cat used about 3 liters of fuel per km or about 200 kg for a 50-km day for two vehicles. This fuel determined how frequently we needed resupply by the single-engine Otter aircraft available. These planes could only carry a few barrels of fuel in one trip depending on our range out of Ellsworth.

Although we commonly saw open crevasses on the traverse, the ones that gave us the most trouble were bridged with snow and could not usually be seen from the surface as we drove along (Fig. 2). Sometimes we could safely drive across snow bridges, but other times we broke through. The Sno-Cats were nearly as safe as a man on skis because of their relatively low weight and four wide tracked pontoons. It is much easier to see bridged crevasses from the air, but this method is severely limited, even when a plane is flying directly over crevasses. We traveled in crevasse country most of the 81 days of the traverse and had a number of incidents of vehicles and sleds breaking through. One man fell in about 10 m, but was rescued safely.

We spaced seismic-glaciology stations at about each day's travel distance (~50-60 km). The measurements at these consisted of a seismic reflection sounding to measure the depth to bedrock; seismic measurement of the increase in sound velocity (and thus snow density) with increasing depth; and a two- or three-meter snow pit to measure snow accumulation and other glaciological parameters such as density and temperature. We would lay out our 330 m seismic cables in an L shape, which we unrolled from chest reels. We would then hand drill a 2–8m deep shot hole at the apex of the L. We fired a small explosive charge of 0.5-2 kg of ammonium nitrate detonated with an electric blasting cap and a 0.5-kg high explosive primer charge. The sound waves penetrated to the ice-water contact (in the case of the floating ice shelf) and to the water-rock (or ice-rock) contact and reflected back to the surface where they were picked up by the geophones. Each of the 24 geophones was attached to one of the channels in the cables. The seismic signals were amplified and recorded on photographic paper which spewed into my hand at 1 m/s. On a few occasions the wet paper record froze in my hands as I wrote the data on the back. There was some hazard associated with laying out the cables when we were working in crevassed areas. In these cases we skied, which offered some protection. We also used skis when we were not in areas of known crevasses, if the snow was soft.

In addition to a snow pit where stratigraphy leading to snow accumulation was measured, Neuburg and Walker, glaciologists, would hand drill a hole 9 m deep and place an electric-resistance temperature probe on a cable in the bottom.

We made gravity and magnetic and altitude measurements every 8 km (Fig. 1) to study the variations in density and magnetic properties of rock beneath the ice, and therefore to make inferences about the ice-covered geology. We also used the gravity data to determine the depth to bedrock between the seismic reflection stations.



Fig. 1. Traverse at intermediate station. Behrendt reading magnetometer at left. Walker and Aughenbaugh making snow hardness measurement left background. Thiel on track of Sno-Cat after making a gravity measurement. Crevasse detector visible on leading vehicle.

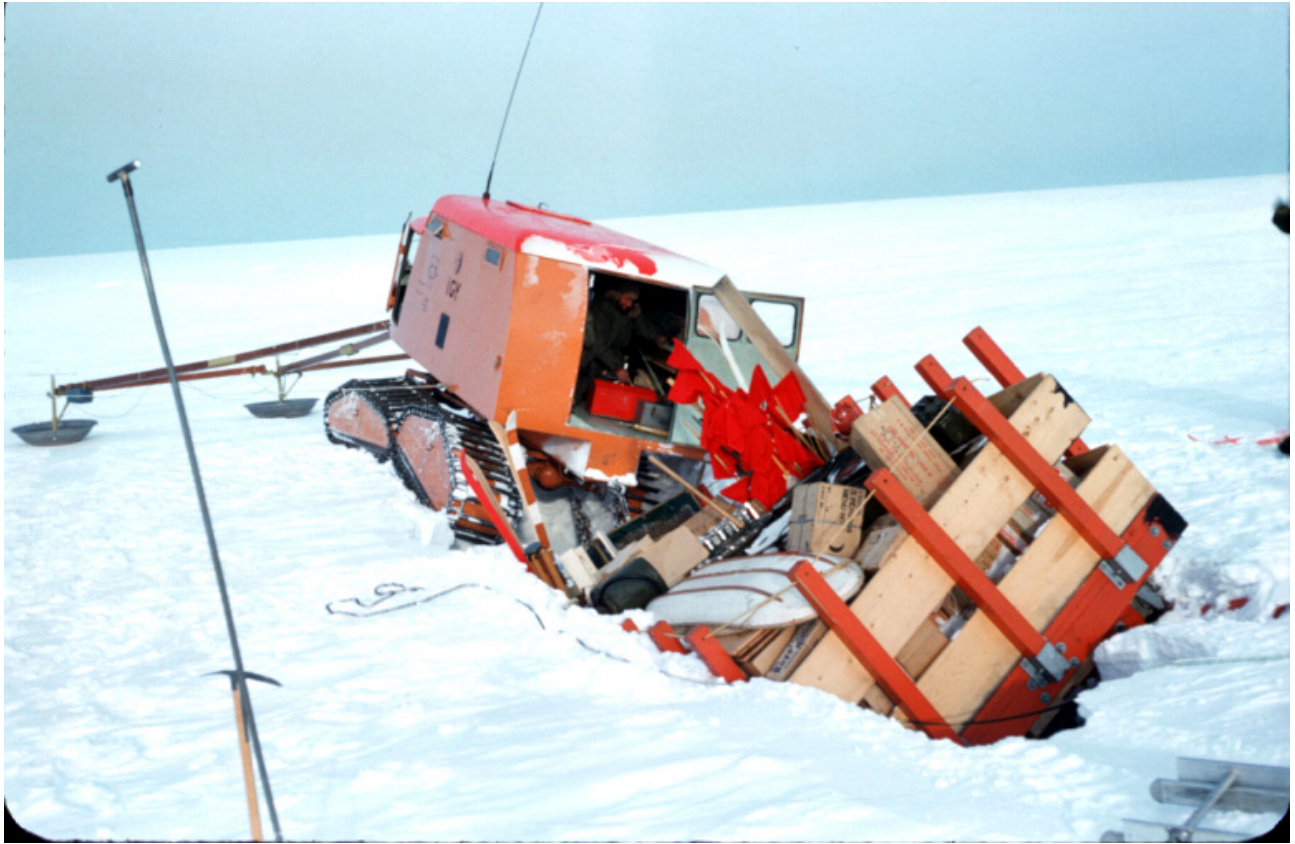


Fig. 2. Sno-Cat and sled broken into hidden, bridged crevasse. Note T-handled probe, ice-axe, and crevasse detector extending forward of Sno-Cat.

## CONCLUSIONS

I will discuss results of this first reconnaissance of the FRIS system including the definition of the Thiel trough beneath the FIS and the maximum ice thickness of the southernmost area of the FRIS of 1300 m which is in significant contrast to BAS re-measurement (Johnson and Smith, 1997) of this area in the 1990s of only 1100 m suggesting significant melting during the interval.

## REFERENCES

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