

## TerraSAR-X makes Antarctica a Better Place

“Polar exploration is at once the cleanest and most isolated way of having a bad time which has been devised”

Apsley Cherry-Garrad. “The Worst Journey of the World” (Survivor of Scott’s second Antarctic expedition)

One of the most dangerous things giving the explorers of the South Pole a bad time like Scott’s “Terra Nova Expedition” (1910-1913) were the open and hidden crevasses and fields of crevasses which could render an expedition obsolete by swallowing sleds, provisions, animals and men unrecoverable.



Scott and his men at Amundsen's base, Polheim, at the South Pole. Left to right: Scott, Bowers, Wilson, and PO Evans. Picture taken by Lawrence Oates.

**The Terra Nova Expedition, officially the British Antarctic Expedition (1910-1913)[1]**

*The routes to the South Pole taken by Scott (green) and Amundsen*



The dangers awaiting Antarctic explorers could be compared with the hazards of today’s human exploration of Moon and Mars. Although nowadays the job descriptions are not as drastic and honest as Sir Ernest Shackleton’s, looking for men for his attempt of an even more ambitious first “Imperial Trans-Antarctic Expedition” starting in 1914, which was initiated after Scott had reached the pole only as second after Amundsen, but succumbed with his entire crew to the hardships on the way back:

“Men wanted for hazardous journey. Small wages, bitter cold, long months of complete darkness, constant danger, safe return doubtful. Honour and recognition in case of success”

(5000 men applied for 28 positions)



**Imperial Trans-Antarctic Expedition (1914–1917) [2]**  
Map showing the sea routes of *Endurance*, *Aurora* and *James Caird*, planned overland route of the transcontinental party, and supply depot route of the *Ross Sea party*

◀ *Dogs watching Endurance in the final stages of its drift, shortly before it sank to the bottom of the Weddell Sea*



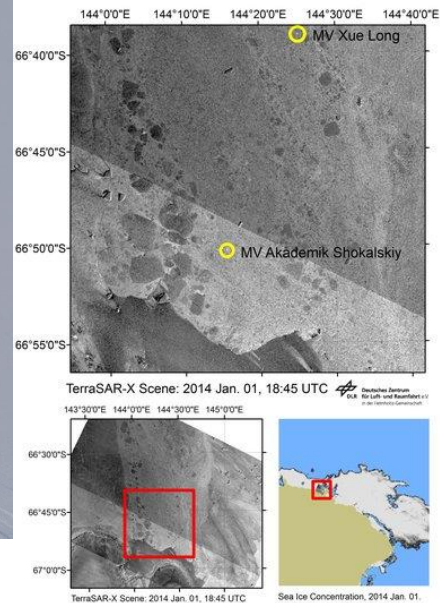
Undeterred by those hazards exploration of the South Pole continued ever since.

Just recently, in March 2018, a four-member research group successfully completed the largest Antarctic expedition since the 1950s. During 1955-1958 the first Antarctic transverse across the South Pole was completed by Sir Edmund Hillary and Sir Vivian Fuchs using air reconnaissance.

Now, in 2018 a team from the New Zealand Government Agency battled their way across a 1000 km long, previously unknown stretch of the Ross Ice Shelf, an ice area the size of France. The vital information for determining the most favorable route was provided by the German Aerospace Center (DLR) with data from the radar satellite TerraSAR-X operated by a team of experts of the German Space Operations Center (GSOC) in Oberpfaffenhofen. [3]



*“The main safety concern getting across the ice shelf was crevassing,” Dr Price says. Photo credit: Neil Silverwood [4]*



The challenge was to plan and find a safe route over unknown terrain over a total of 1,000 kilometers in the ice shelf - with success: "Without satellite data, it would have been impossible, or very, very lucky, not to hit crevasses on the way". We only had to deviate one time from our planned route", says expedition member Dan Price from the University of Canterbury in Christchurch, New Zealand.[3]

**“We can use this data to weave in and out of the hazards – without it we’d be navigating a minefield blind,”**

**(Dr Daniel Price University of Canterbury, New Zealand).[4]**

The successful traverse serves the international "Ross Ice Shelf Project", which investigates how the ice shelf reacts to the global warming.

As pointed out above, the biggest risk when crossing any ice shelf is the existence or unexpected formation of crevasses. For example, under the blanket of snow, crevasses can be hidden that reach all the way down to sea level. "Without the data, it would be as if we are moving blindly in a minefield." In the past, optical images were used, which were composed essentially by photographs taken from satellites. “With the aid of the radar images, it is possible to map gaps and crevasses better and safer”, explained Dana Floricioiu (DLR). The radar satellite looks through clouds and dry snow, revealing the hidden and therefore more dangerous disruptions and gaps.

As microwaves penetrate snow and ice, TerraSAR-X sensors are sensitive to near-surface physical properties such as the wetness and roughness of the imaged surface. The satellite operates in the so-called "X-band", the frequency range of 9.65 gigahertz, and is a valuable tool for spatially extended

investigations of fine structures on ice and snow. Features such as flow lines and crevasses can be observed in detail and used to study the flow dynamics of glaciers and ice streams. The radar also has various modes of operation, allowing fine details to be mapped in high resolution as well as large areas.[3]

“Many satellites are restricted in where they can observe, but TerraSAR-X allows a view much further south over the Antarctic. This allowed the New Zealand expedition to plan in detail to the required 84 degrees south, less than 700 km from the South Pole”.  
(Dana Floricioiu of the German Aerospace Centre DLR) [3]

The use of satellite imagery had paid off tremendously on the Ross shelf ice. "In this monotonous and environment without any structure, we were able to use the radar images to accurately understand where we were at every instance", says Price [4]. The radar analysis also revealed up to now unknown information e.g., that parts of the ice shelf are no longer aground the seabed but begin to float.

By successfully traversing the southernmost part of the shelf, the expedition team was able to identify locations for drilling through the ice shelf to obtain information about the ice, the ocean, and the sediments on the seabed.[3]

#### *Request for a New Mission*

DLR would like to build on this success and utilize the follow-up mission to TerraSAR-X, the "Tandem-L" project. The aim is to map the land mass of the Earth on a weekly basis. The high temporal and spatial data could provide access to the sensitive Pole regions and provide much needed environmental and climate research information to monitor ice dynamics and structure, the researchers hope. An application for this new mission has already been submitted and is in the approval process. [3]

#### References

[1] Terra Nova Expedition [https://en.wikipedia.org/wiki/Terra\\_Nova\\_Expedition](https://en.wikipedia.org/wiki/Terra_Nova_Expedition)

[2] Imperial Trans-Arctic Expedition  
[https://en.wikipedia.org/wiki/Imperial\\_Trans-Antarctic\\_Expedition](https://en.wikipedia.org/wiki/Imperial_Trans-Antarctic_Expedition)

[3] DLR Bericht und Bild: [https://www.dlr.de/eoc/desktopdefault.aspx/tabid-12632/22039\\_read-52200/](https://www.dlr.de/eoc/desktopdefault.aspx/tabid-12632/22039_read-52200/)

[4] University of Canterbury: <http://www.canterbury.ac.nz/news/2018/uc-glaciologist-x-rays-ice-shelf-in-largest-antarctic-traverse-since-1950s.html>