Antarctica is not all snow and rock. Plants do live here, mainly mosses, lichens and rare grasses. This is an area of mixed rock and vegetation on Anchorage Island, close to Rothera Research Station.

MAPPING from on high

Is it time for Antarctic geologists to hang up their hammers? **Christian Haselwimmer** and **Teal Riley** are using satellites to identify rocks and plants in Antarctica.

In a continent as vast and inaccessible as Antarctica even with all our technological advances it is still a hugely challenging place to do field work. Our choices are constrained by aircraft logistical limits and the hazards of glacier travel in highly mountainous areas. As a result, Earth observation in polar regions using satellite or airborne platforms are well-established techniques to aid investigations of the atmosphere, oceans, cryosphere and subglacial geology.

The British Antarctic Survey (BAS) and Imperial College, London are exploring the potential for using satellites to identify rock types (lithological mapping) and map vegetation. This has been done in other parts of the world, but their use in mountainous regions and around ice sheets is in its infancy. In these areas it presents many new problems like the effect of snow and ice on rock reflectance, strong mountain shadowing, and the limited nature of rock outcrop and vegetation. All these factors make it a challenging place for interpreting satellite data.

Christian Haselwimmer gathering field specimens from mountainous outcrops on Adelaide Island.

We're using satellite images from NASA's ASTER sensor. These record the sunlight reflected off the Earth's surface at different wavelengths: from the visible-to-shortwave infrared region. Minerals in rocks reflect light differently at these wavelengths. We can use this property to discriminate different rock types in satellite images. Similarly, the way plants reflect light means we can use the same techniques to work out the extent and health of plants from satellite images.

To get the most information from the satellite data, we decided to 'ground truth' some well-known areas. In January 2009, during the short Antarctic summer, we went to Adelaide Island, close to BAS's Rothera Research Station on the Antarctic Peninsula.

Key rock types have quite distinctive reflectance properties.

We wanted to gather direct measurements of the reflective properties of different rocks and vegetation types and make field observations to relate what we see on the ground to the satellite data. By confirming our observations in one location we can be more confident about the results we get across the much larger area covered by the satellite images. Adelaide Island is a good area for doing this. The geology has been mapped in detail and there are significant areas of vegetation and lichens on the islands near the Rothera base.

We used a field spectrometer borrowed from the NERC Field Spectroscopy Facility. This measures reflected light in the visible-to-shortwave infrared region to produce reflectance spectra. Because the equipment had never been used to measure rock reflectance in such a harsh environment we tested it

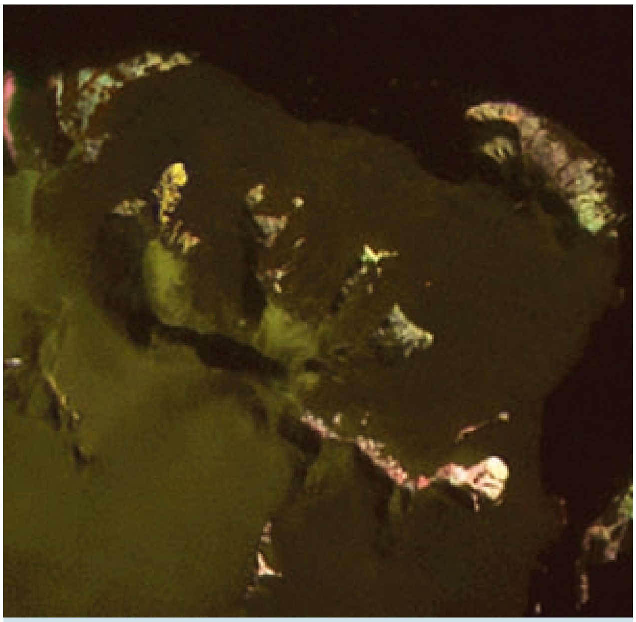

Image from NASA's ASTER satellite highlights rock types in the study area. The different colours reflect the mineral composition of the rocks. Snow and ice are dark green in this composite image.

to establish the best field practice. For the different rocks and vegetation types we selected appropriate field specimens that we analysed in the lab. We also used the spectrometer in the field to gather spectra directly from outcrops and areas of vegetation when weather conditions were sunny.

Early analysis of the field data has demonstrated that many of the key rock types have quite distinctive reflectance properties. We have used these results to assist our analysis of the ASTER image. As a result we have been able to discriminate many of the main rock types exposed in the study area and our satellite map shows good agreement with the existing geological information. The next steps for the research are to extrapolate what we have found on Adelaide Island to the much more poorly understood and unmapped regions farther east.

For the time being satellite images cannot replace fieldwork.

Our analysis of different vegetation types has also produced important results. Significantly, we have been able to build a spectral library of Antarctic Peninsula vegetation types that will be important for future work. We have also demonstrated how field surveys can be used to estimate the fractional cover of different vegetation types. We intend to use these results to validate satellite-derived vegetation maps.

The research from Adelaide Island has been particularly useful, as it has shown us what we can and can't achieve using satellite remote sensing. For the time being, satellite images cannot replace fieldwork as a means of undertaking detailed geological or vegetation mapping. However, our results have shown that careful analysis of remotely sensed images can provide a significant extra source of information for improving the coverage and quality of maps from the Antarctic Peninsula. This information will be important for refining models of the geological evolution of the peninsula, which provides the boundary conditions for a variety of palaeoclimatic and palaeogeography research. ❖

Field assistant Adam Clark gathering field reflectance spectra from the Rothera runway to be used as a reference standard.

The researchers measured how grass in Antarctica reflected light.

MORE INFORMATION

Christian Haselwimmer is a NERC-funded PhD student at the British Antarctic Survey and Imperial College, London.

Teal Riley is a field geologist and geochemist at the British Antarctic Survey.