THE RADARSAT ANTARCTIC MAPPING PROJECT

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INTRODUCTION

During September and October 1997, the Canadian Radarsat-1 was used to successfully acquire the first, high-resolution synthetic aperture radar image data set of the entire Antarctic Continent. This unprecedented activity was made possible by the in-orbit rotation of the SAR to look towards the South Pole and the electronic beam steering capability of the instrument to image to the Pole. These attributes, combined with the ability to operate day or night and to penetrate cloud, provide a nearly instantaneous snapshot of the southern continent.

A composite mosaic constructed from over 3000 Radarsat-1 frames processed immediately after the mission by the Alaska SAR Facility is shown in Fig. 1. These Quick-look images were processed throughout the Antarctic Imaging Campaign (AIC) on the Jet Propulsion Laboratory designed Alaska SAR Processor. Quick-look images are 100 km on a side, are not radiometrically or geometrically calibrated and, in this case, have 100 m pixel size. The images were originally intended to verify that swaths overlapped at the coast and to visually verify data quality as it might be used to make real time changes in the acquisition plan. In fact the composite reveals extraordinary details about the glaciologic and geologic structure of the Antarctic. It is indeed a new view of Antarctica and provides for a quantitative analysis of surface properties over all of East and West Antarctica (Fig. 1 and 2).

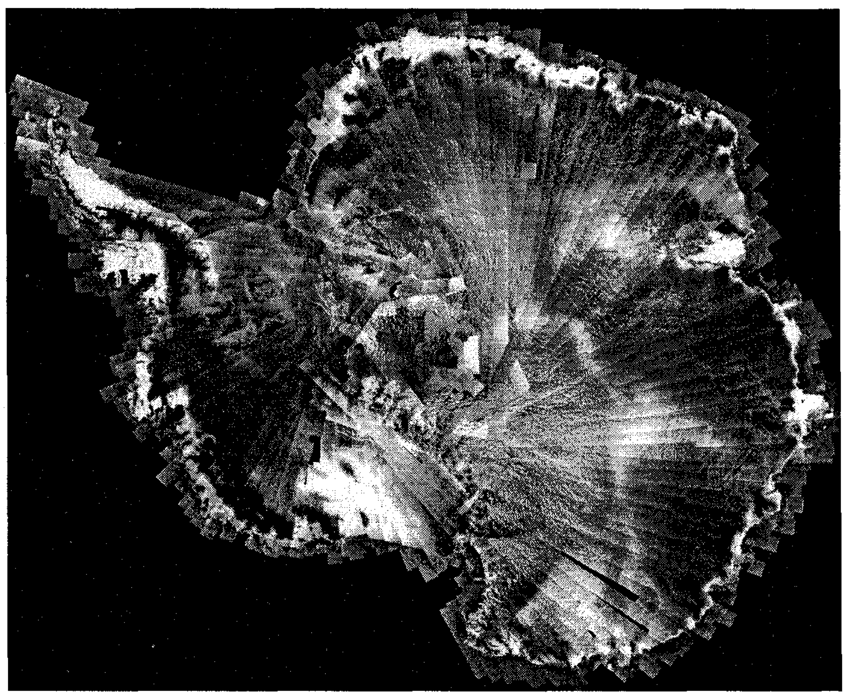

Figure 1. Synthetic Aperture Radar Mosaic of Antarctica. Data were acquired by Radarsat-1 during September and October 1997.

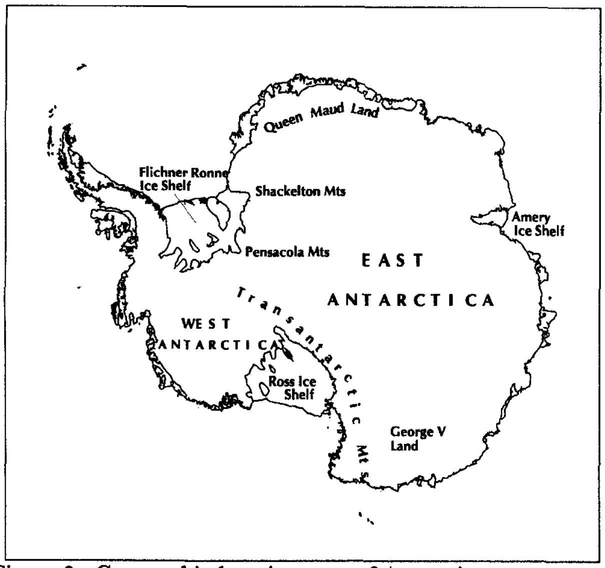

Figure 2. Geographic location map of Antarctica

DISCUSSION

We observe several new and exciting features about Antarctica from the mosaic (Fig. 1). First, there are large-scale spatial variations in radar brightness. Many of the thousands of kilometer long curvilinear features across East Antarctica appear to follow ice divides separating some of the large catchment areas. The bright portion of Marie Byrd Land in West Antarctica and the eastern sector of the Ross Ice Shelf probably represent the region where significant melting and refreezing occurred during an early 1990's melt event. Most of the coastal areas and much of the Antarctic Peninsula appear bright also because of summer melt. But unlike Greenland, where most of the large-scale brightness patterns are associated with firn melt facies, the remaining, strong variations in radar brightness are poorly understood.

On an intermediate scale, the East Antarctic Ice Sheet appears to be very 'rough'. The texturing is probably primarily due to the flow of the ice sheet over a rough glacier bed. Textures are particularly strong paralleling the flanks of the Transantarctic, Pensacola and Shackelton Mountains and extending deep into adjacent portions of the East Antarctic Plateau. Long linear patterns are strongly suggestive of subglacial geology and may indicate that the ice sheet in this area is resting on relatively resistant basement rocks. The texture changes abruptly across the northernmost section of the Wilkes Subglacial Basin located in George V Land. There the imagery shows remarkable subtle rounded shapes similar in appearance to the signature of subglacial lakes such as Lake Vostok.

Wind driven surface and ice driven processes are manifest at scales across the mosaic. Extensive dune fields are observed across East Antarctica. The dunes have wavelengths of several kilometers and may be 40 kilometers in length.

Figure 3. East Antarctic Ice Streams. The center of the image is located at about 82° S. 35.4° W. The image is 880 km wide.

Most intriguing are the ice stream and ice stream like features in Queen Maud Land made visible by the intense crevassing along the shear margins. Slessor Glacier is located in the upper middle portion of Fig. 3. The upper reaches of the glacier are funnel shaped, channeling ice downwards towards the Filchner Ronne Ice Shelf which occupies most of the left of the figure. The northern most shear margin is about 230 km long from the grounding line to the upstream area that seems to be characterized by recently initiated or relict ice stream flow. An enormous ice stream, reaching at least 550 km into East Antarctica, feeds Recovery Glacier. The confluence of a thin, elongated, 270 km-long tributary ice stream with Recovery Glacier is located approximately 250 km from the constriction where Recovery Glacier enters the Filchner Ronne Ice Shelf. The main body of the tributary is crevasse free indicating that shear stresses are concentrated only at the margins. A less active tributary merges with Recovery Glacier just upstream of the grounding line. Support Force and Foundation Ice Streams are located in the lower middle of the image. The upglacier portion of Foundation Ice Stream forks into two tributary streams that extend about 180 km into East Antarctica. Taken together, these East Antarctic Ice Streams are significantly more

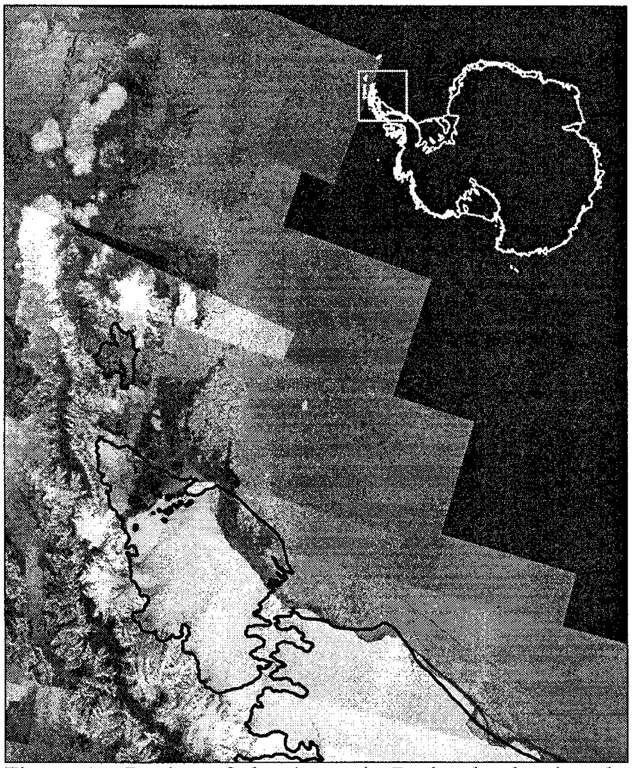

Figure 4. Portion of the Antarctic Peninsula showing the region that formerly contained the Northern Larsen Ice Shelf. The dark tones offshore of the Peninsula and remaining Larsen Ice Shelf are indicative of coastal polynas. The black line shows the grounding line and the former seaward extent of the ice shelf.

extensive than the more studied West Antarctic Ice Streams. The presence of the ice stream system also suggests more active mechanisms for moving ice out of the East Antarctic Ice Sheet – perhaps indicating a potentially more changeable ice sheet than previously imagined.

Finally, the grounded and floating margins of the ice sheet are clearly discernable in Fig. 1. Initial inspection and comparison with historical data sets (such as the British Antarctic Survey Antarctic Digital Database) suggests that there are no systematic patterns of ice margin advance or retreat. For example, the ice fronts of the Ross and Amery Ice Shelves have advanced since the mid-1980's. As documented by several authors, the northern Larsen Ice Shelf experienced nearly catastrophic retreat in 1995 (Fig. 4). Interestingly, the ocean region formerly covered by the northern Larsen Ice Shelf is now covered by either very thin ice or by open ocean – both conditions indicative of southern ocean polynya formation. The areal extent of the new thin ice region is about 9630 km^2. The presence of either open water or thin ice contributes a new source of heat flux from the coastal ocean into the local environment.

SUMMARY

Preparation of a radiometrically calibrated and geometrically accurate mosaic is proceeding under the Radarsat-1 Antarctic Mapping Project [1, 2, 3]. The mosaic final, seamless, digital mosaic will be produced at 25 m pixel size and be distributed on CDROM. The mosaic will be available for use by the science community in late 1999.

ACKNOWLEDGMENTS

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REFERENCES

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