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Evidence for Possible New Subglacial Lakes along a Radar Transect Crossing the Belgica Highlands and the Concordia Trench

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INTRODUCTION

Subglacial lakes are of great interest to the scientific community, and more than 140 lakes have been identified in Antarctica and catalogued (Siegert et al., 2005, Cafarella et al., 2006).

We report on the possible existence of 5 new subglacial lakes in the area between the Belgica HighLands and the Concordia Trench. Analysis of radar data collected during the 2003 Antarctic field survey reveals particularly strong radar echoes coming from the subglacial interface. As radar surveys are only one of the methods used to identify subglacial lakes, the presence of these 5 new lakes must be discussed and confirmed through other geophysical investigations.

DATA COLLECTION AND PROCESSING

During the Italian Antarctic field survey in 2003, airborne radar measurements were made around Dome C (Fig. 1) to better define geological structures such as the Concordia and Aurora trenches and the Concordia, Aurora and Vincennes subglacial lakes (Forieri et al., 2004). Data were collected with a radar system operating at 60 MHz frequency and acquiring 10 traces s^{-1} with a pulse length of 1 μs. The total range time for each trace was 64 μs with a vertical accuracy of 50 ns, *i.e.* 1280 samples (Tabacco et al., 1999). Radar instrumentation was linked to a GPS system in order to exactly locate each recorded trace. The GPS data acquisition frequency was 10 s.

We only focus on one of the collected radar profiles (profile A-B in Fig. 1), located at a latitude of -76° S and between longitudes 123°24′ E and 128°12′ °E, for a total length of about 130 km. The east-west flight path went from the Belgica Subglacial Highlands to the southern end of the Concordia Trench.

Figure 2 shows in its upper pasrt the radargram of the profile along the flight path (*i.e.* from right to left in Fig. 1 and in the lower part of Fig. 2); the bottom reflection is clearly visible all along the track. A semiautomatic software was used

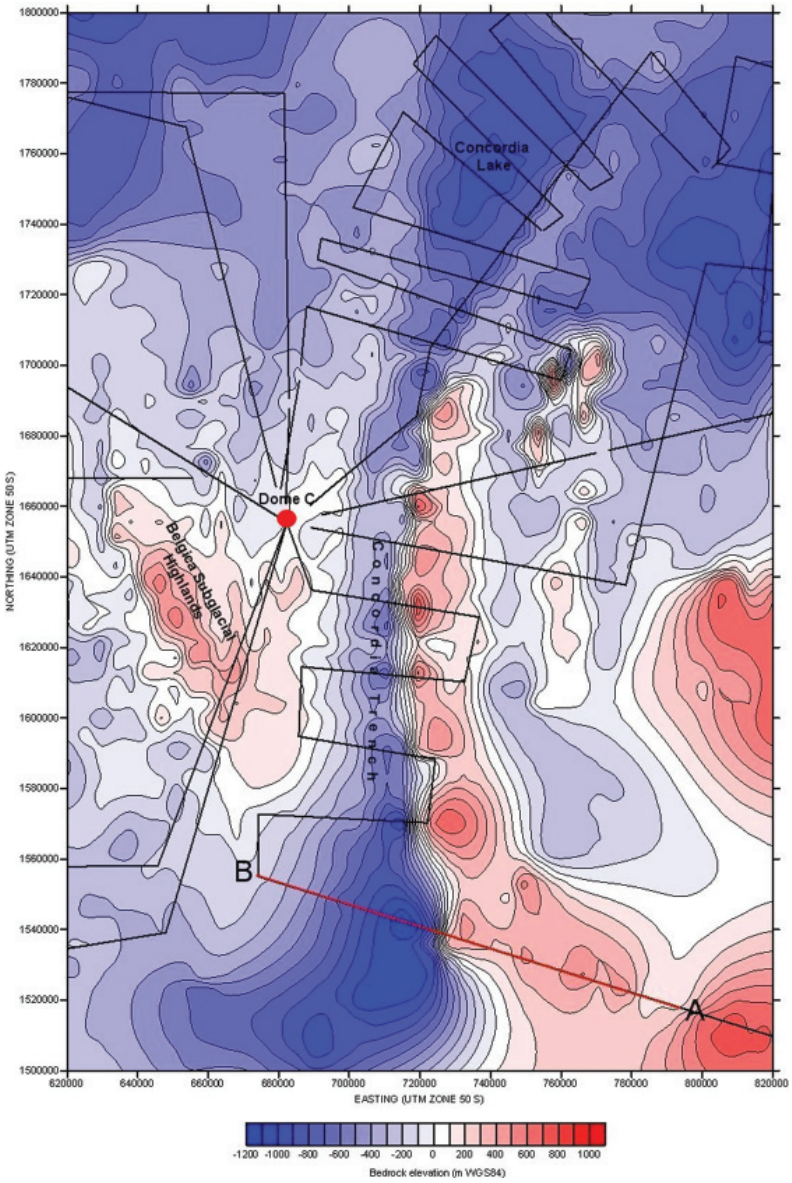

Fig. 1 – Position of all radar data collected during the 2003 PNRA expedition superimposed on the bedrock map of the Dome C area. The dashed red line indicates profile A-B.

to pick up echoes from the surface and from the bottom of the ice sheet and to obtain the two-way reflection time. Ice thickness was calculated assuming a constant electromagnetic wave velocity in ice of 168 m μs^{-1} (Glen & Paren, 1975, Bogorodskiy et al., 1985) without any correction for firn density.

The ice thickness along the profile is about 3 km over the Belgica Highlands, with bumps and hills typical of a mountain section, and increases to more than 4.3 km in the Concordia Trench.

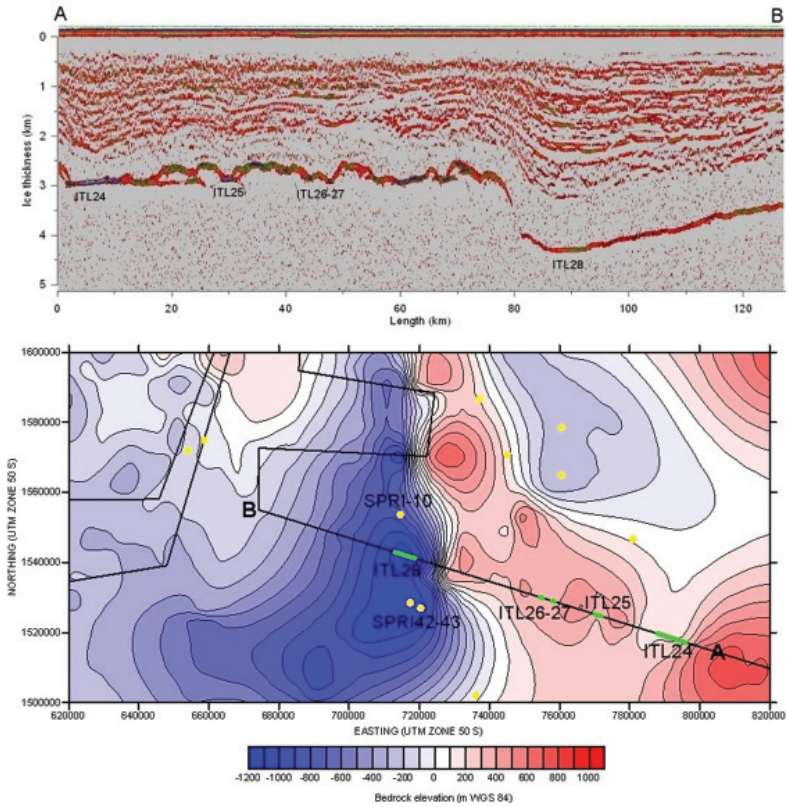

Fig. 2 – Upper part: radar section of profile A-B. Lower part: location of possible new lakes (green lines) and previously identified lakes (yellow dots, from the lake inventory of Siegert et al. 2005).

LAKE IDENTIFICATION

Strength of basal echo is related to the electromagnetic reflection coefficient between the ice sheet and the bed. Higher the reflected power, most likely an higher electromagnetic coefficient of the material at the base of the ice sheet. The subglacial interface shows different "segments" where basal reflections are stronger than the surrounding ones. Such reflections may be ascribed to the presence of a subglacial lake if other conditions are met, namely: a flat horizontal reflector, radar echoes constant and 10-20 dBm stronger than those of the surrounding areas, and sharp edges similar to the margins of a catchment basin (Siegert, 2000).

All these conditions are met in five distinct areas, suggesting the presence of five new subglacial lakes. Following the Italian inventory classification, they were named ITL24, ITL25, ITL26, ITL27 and ITL28 (Fig. 2 lower part). Table 1 summarizes the length, location and physical characteristic of these lakes.

Lakes ITL24, ITL25, ITL26, ITL27 are located on the Belgica Highlands; their dimensions vary from less than 1 km to 8.7 km. There is a flat topographic anomaly above the largest one. On the contrary, no surface anomalies were found above the three other lakes, confirming that their dimensions are too small to modify the surface of the ice sheet (Siegert & Ridley, 1998). Lake ITL28 probably corresponds

Tab. 1 - Features of new possible subglacial lakes derived from radar data. Longitude, latitude, ice thickness and elevation refer to the radar trace of the centre of the lake.

Lake Id	Track Length (km)	Longitude °E	Latitude °S	Ice Thickness (m)	Elevation (m WGS84)
ITL 24	8.7	128.000	76.171	2936	158
ITL 25	2.0	127.189	76.147	2881	238
ITL 26	0.8	126.690	76.131	2856	277
ITL 27	0.8	126.559	76.127	2910	225
ITL 28	5.6	125.058	76.071	4300	-1154

to the previously identified SPRI-22 or SPRI42-SPRI43 (Siegert et al., 2005); it lies in the southern and deepest part of the Concordia Trench and is 5.6 km wide.

CONCLUSIONS

We report possible radar evidence for five subglacial lakes in the Dome C area. According to the classification proposed by Tabacco et al. (2006), four lakes on the Belgica HighLands are Range lakes, while the fifth lake on the southern part of the Concordia Trench is a Trench lake. As one of the lakes has probably already been inserted in a previous inventory of subglacial lakes, the newly identified subglacial lakes are four. This brings the total number of lakes thus far discovered in Antarctica to 149.

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