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TALOS Dome Migration: Preliminary Results

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INTRODUCTION

Ice divide-dome migration is a key parameter in mass balance studies and in the interpretation of ice cores. The stability of the dome and position of the ice divide must be known to accurately interpret ice core records and to complete mass balance studies. Models of depth-age relationships for deep ice cores are sensitive to migration of the dome position (Anandakrishnan et al., 1994). The evolution of an ice divide is driven by the accumulation-rate history, its spatial pattern and conditions at ice-sheet boundaries (*e.g.* Frezzotti et al., 2004; Hindmarsh, 1996; Nereson et al., 1998). Ice divide migration is also important in determining the input parameter of large Antarctic drainage basins. Due to the very low slope (less than a decimetre per km) of East Antarctic domes and to surface morphology (e.g. sastrugi), it is very difficult to determine the summit point of a dome and its migration in time. In 2004 a new ice coring project, TALDICE (Talos Dome Ice Core Project), started at TD to recover 1550 m of ice spanning the last 120 000 years (Frezzotti et al., 2004).

This paper discusses preliminary findings on the present and past morphology of Talos Dome based on detailed snow accumulation data, radar-derived isochrons and ice velocity measurements in the last 10 years.

MATERIALS AND METHODS

It has been shown that internal layers of strong radar reflectivity observed with Ground Penetrating Radar (GPR) are isochronous and that surveys along continuous profiles provide detailed information on the spatial variability of snow accumulation (*e.g.* Richardson et al. 1997; Vaughan et al., 1999; Frezzotti et al., 2005). Six shallow snow-firn cores were drilled in the TD area (Frezzotti et al., 2004; Stenni et al., 2002, Magand et al., 2004). Snow radar coupled with GPS (Global Positioning System) surveys link all core sites in order to provide detailed information on the spatial variability of snow accumulation. Strain networks established in the TD area have been surveyed (using static GPS) since 1993.

GPR data acquisition was performed using a GSSI Sir10B unit equipped with a 200 MHz central frequency monostatic antenna. The recorded two-way travel times (TWT) were converted to depths following the methodology based on density-depth information outlined in Frezzotti et al. (2002). Density information was obtained using 3 firn/ice cores (26 to 89 m deep) and 2 trenches (2.5 m deep). All density data were fitted with a second-order polynomial function for each dome area, yielding a correlation coefficient (R^2) of more than 0.9 for measured and computed densities. Layer depths measured at intersecting points are in good agreement (± 25 cm), and four continuous internal layers were tracked along all profiles (S1, S2, S3 and S4). Frezzotti et al. (2004) used core analysis to establish a depth-age function: S1 (14.8 m) dates to AD 1920±25, S2 (26.7 m) to AD 1835±25, S3 (49.3 m) to AD 1635±24, and the deepest traceable S4 (61.2 m) to AD 1525±23.

Surface strain networks were placed 8 km from the centre of TD and consisted of a total of 9 stakes. GPS measurements of the networks were completed 4 times at TD. Reference poles (located close to the dome summits) were positioned through static GPS measurements; the Terra Nova Bay permanent GPS station was the base station. Process details are reported elsewhere (Frezzotti et al., 2004).

RESULTS

Frezzotti et al. (2004) pointed out that at TD the palaeo-surface of the 4 layers and the present morphology are coherent, and indicate that the dome has changed in dimension and shape, with a reduction in the NNE portion. The migration of morphology in the NE area is opposite to that of ice flow, but agrees with the direction of prevailing winds (SSW to NNE) and with the surveyed patterns of decreasing accumulation in the NNE area and of increasing accumulation in the SSW area. The distance between contour lines and the relative palaeo-surface reveals that the summit area (highest contour line) has migrated about 3.5 m yr^{-1} since the deposition of layer S4 (Fig. 1; AD 1525).

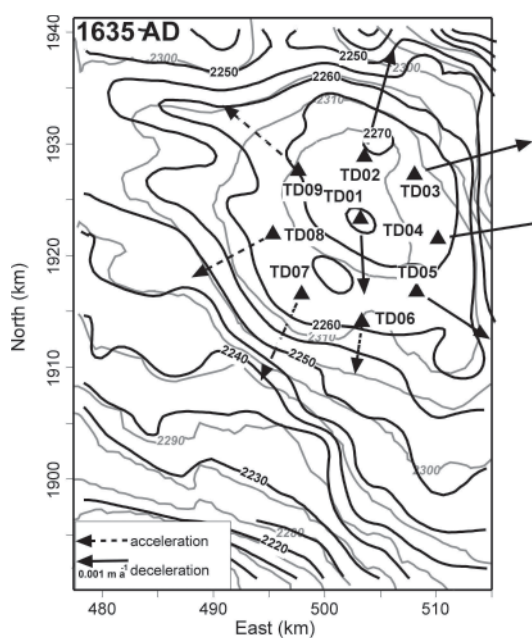

Fig. 1 - Ice velocity variation and palaeomorphology of Talos Dome. The present surface topography (grey) and palaeosurface map (AD 1635, black) of the area with a 5 m contour interval. The height of the palaeosurface was normalised using the maximum height of this layer with respect to the present maximum elevation.

At TD the highest horizontal velocities are recorded in the “steeper” S-SW and E-NE slopes, whereas the lowest horizontal velocities are recorded close to the dome summit and along the SE ice divide (Frezzotti et al., 2004). Data reveals (Fig. 1) deceleration from 5±3 to 2±3 mm yr^{-2} in the N-SE sector (from TD01 to TD05) and acceleration from 4±3 to 1±3 mm yr^{-2} in the NW-S sector (from TD06 to TD09). Although velocity changes of less than 3 mm yr^{-2} are below the measurement uncertainty, the geographical distribution of all acceleration/deceleration measurements are coherent at each site, and 5 out of 9 values are higher than the uncertainty in the measurement. The bearing rotates counterclockwise in the N and NW portions and clockwise in the other sectors. The snow radar profile revealed that accumulation has increased by about 10% in the SW sector. Due to the very low slope gradient, it is difficult to assess variations in slope.

CONCLUSIONS

The accumulation map obtained from snow radar data reveals a spatial variability in the snow accumulation rate at Talos Dome. Accumulation distributions are not symmetrical with respect to the dome morphology. The palaeo-surface of Talos Dome indicates that the dome has changed dimension, slope and shape over the last centuries. The Talos Dome summit morphology has migrated SW by about 3.5 m yr^{-1} in the last 500 years, with a decrease in velocity in the NE portion and an increase of the order of some mm yr^{-2} in the SW portion.

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