The Cryosphere Discuss., 3, C39–C41, 2009
www.the-cryosphere-discuss.net/3/C39/2009/

The Cryosphere Discussions

TCD
3, C39–C41, 2009

Interactive Comment

Interactive comment on "Layer disturbances and the radio-echo free zone in ice sheets" *by* R. Drews et al.

M. Pelto

mauri.pelto@nichols.edu

Received and published: 8 May 2009

This paper is a valuable companion to the first accepted Cryosphere paper, which examined the role of conductivity and crystal fabric orientation as sources of radio echo reflector horizons in the vicinity of the EPICA drill site Dronning Maud Land, Antarctica (Eisen et. al., 2007). In Drews et. al., (2009) the analysis of the radio echo sounding record in the vicinity of EPICA is extended to the radio echo free zone (EFZ). In Eisen et. al., (2007) a careful differential diagnosis is made that establishes the cause of the last major reflector before the EFZ in the EMDL core is due to change in crystal fabric orientation (COF), not conductivity. The following comments are not a comprehensive review of this paper. They are made from the background of an alpine glaciologist who specializes in working at the surface of temperate glaciers, and reflect either my

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

misunderstanding of the issue, or a need to more comprehensively discuss the nature of the EFZ. The paper examines a fascinating mystery, with a limited list of suspects, and I look forward to further review of the evidence fingerprinting the suspect.

Figure 1, indicates the abrupt change from numerous reflector horizons to none. This image is too small to adequately convey the completeness of the change from numerous reflectors to the EFZ spatially. I recommend using two figures separating either by profile or pulse length. It would also be pertinent and useful, given the limited literature on the subject, to include an RES profile from another location, previously published, to illustrate the nature of the EFZ in diverse settings. For example the RES profile from near Vostok could provide a compliment indicating that the EFZ is not related to bed topography as it exists over mountainous basal areas and Lake Vostok. This would also illustrate that the EFZ is not dependent on a specific flow setting, for example at a flow divide versus along a flow line.

The authors refer to Fujita's (2006) identified sequence of 4 radio echo zones: the density driven near surface zone, the conductivity zone, the COF zone, and last the EFZ zone. In Figure 3 it would be nice to see the bracketed delineation of these various zones not just the EFZ.

The case has been made that a change in COF can cause an internal reflecting horizon and did cause the last substantial reflecting horizon (Eisen et. al., 2007). More attention needs to be paid to COF changes or lack thereof in the EFZ. A COF reflector would represent a change in the stress and strain history occurring along some plane. That no such reflector horizon, or very few anyway, occur in the EFZ suggests a zone with no significant COF planes. Would not the COF either be relatively consistent or completely incoherent in the EFZ to have no planar reflecting horizon? Siegart and Kwok (2000), note in the Lake Vostok core, that there is abundant crystal alignment at ice depths greater than 2700 m, resulting in ice layers with preferred COF across Lake Vostok at ice depths greater than 2800 m. An examination of the RES from the Lake Vostok area indicates this depth band coincides with the EFZ. Drews et. al., (2009) and Eisen. al., (2007) note the anisotropic COF below 2040 m. This to me suggests a consistent COF in a bed parallel shear dominated environment as noted by Pettit (2007).

It is noted in Figure 2 and in the text that the cloudy bands lose their perfectly parallel nature at the transition to the EFZ and are often folded, faulted and tilted. Hence, the upper bound of the EFZ would be the zone where depositional layering loses lateral continuity. In Figure 2 within the EFZ as the authors note most of the layers remain parallel, this suggests the possibility of a different explanation. That COF becomes dominant due to the development of an anisotropic fabric due to crystal growth and reorientation. Do the crystals cross a threshold size large enough to cross the small scale layers-cloudy bands, possibly reducing a coherent reflection from them? As the anisotropy develops at the top of the EFZ the depositional layer properties then are secondary to crystal and crystal fabric properties. What has been observed that makes this explanation less plausible? In either case it is ice sheet flow properties that is causing the loss of reflecting horizons.

Interactive comment on The Cryosphere Discuss., 3, 307, 2009.