Limited Pleistocene glaciation in Deep Freeze Range, Northern Victoria Land, Antarctica, derived from in-situ cosmogenic nuclides

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The Cenozoic evolution of landscape and climate in Antarctica remains controversial. One hypothesis assumes that the Dry Valleys with their very cold and hyperarid conditions prevailing since at least Mid-Pliocene are representative for the entire continent (Denton et al. 1993). On the other hand, it was argued that the Dry Valley's tectonic block experienced a unique uplift history and thus a special climatic and landscape evolution (Van der Wateren et al., 1999).

The latter hypothesis can be tested by investigating ice free areas outside the Dry Valleys. The Terra Nova Bay region (75°S), Northern Victoria Land is one of the very few appropriate spots in Antarctica for this purpose. We determined ages of erratics and scoured bedrock with in-situ produced cosmogenic nuclides ^{10}Be, ^{21}Ne and ^{3}He.

We investigated one site near an outlet glacier of the East Antarctic Ice Sheet (EAIS) and one near a local mountain glacier in order to evaluate potential differences in response to climate changes between ice sheet and local glaciers.

The ages obtained show that the mountains in Northern Victoria Land are free of ice since at least 4 Ma. This implies a formation of the landscape prior to Mid-Pliocene and very restricted erosion since then. Erratics on valley walls yield much younger exposure ages and thus indicate that subsequent ice coverage was restricted to valleys, both along the EAIS draining paths and in the local mountain glacier networks. At least three Pleistocene ice advances could be dated, the youngest of which is consistent with the Last Glacial Maximum of the northern hemisphere.

This set of exposure ages is consistent with the findings from the Dry Valleys: the Antarctic climate was cold and hyperarid since the Pliocene. Particularly, it indicates only restricted advances of both mountain glaciers and plateau drainage glaciers throughout the Pleistocene.

References

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The Fish Canyon Tuff: Ar-Ar versus U-Pb age discrepancy re-assessed

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Sanidine from the Fish Canyon Tuff (FCT; San Juan volcanic field, Colorado USA) is widely used as a neutron fluence monitor in ^{39}Ar-^{40}Ar dating. Intensive calibration work carried out over the last two decades has converged at an Ar-Ar age of ca. 28.0 Ma (Villeneuve et al., 2000, and references therein). This age, however, is distinct from a mean ^{238}U-^{206}Pb single-zircon age of 28.41±0.05 Ma (Oberli et al., 1990) and a similar, recently reported high-precision age of 28.478±0.024 Ma (Schmitz and Bowring, 2001).

New petrologic evidence suggests that the batholithic-scale magma chamber was cooling to near-solidus conditions before being partially remelted by mafic recharge, ultimately triggering eruption (Bachmann et al., in press). This model is supported by zircon U-Pb data and ^{39}Ar-^{40}Ar ages obtained on phenocrysts from the Pagosa Peak Dacite (precursor of FCT), the FCT (outflow facies), Nutras Creek Dacite (post-FCT lava) and three xenoliths from the FCT exhibiting FCT mineralogy. Partially resolved disequilibrium-corrected ^{238}U-^{206}Pb dates obtained for 24 out of 25 air abraded zircons span an interval of ca. 28.62–28.04 Ma and yield a weighted mean age of 28.36±0.06 Ma (95% c.l. ext.), with MSWD=26 indicating scatter grossly in excess of analytical precision (typically, $1\sigma \leq 0.05$ Ma for an individual measurement). There is no correlation of these U-Pb ages with lithology.

While 61 out of 62 ^{39}Ar^{40}Ar total fusion experiments on sanidine phenocrysts from the three eruptive lithologies gave indistinguishable mean ages at 27.99±0.08 Ma, plagioclase, biotite and hornblende yield slightly higher ages of 28.2-28.3±0.2 Ma. CO_2-laser 24-step incremental heating on a feldspar megacryst from a pumice of the FCT produced a relatively flat plateau at 28.23±0.18 Ma (~75% of argon release), with the last eight steps (<20 % of argon release) yielding an inverse-isochron age of 28.75±0.32 Ma.

We interpret the pre-28.0 Ma age dates as evidence for extended magma chamber residence, which invalidates the use of FCT zircon ages as a constraint for Ar-Ar calibration.

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