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Channel Flow, Ductile Extrusion and Exhumation in Continental Collision Zones

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THIS VOLUME IS DEDICATED
TO THE WORK OF
KARL DOUGLAS NELSON
26 March 1953–17 August 2002

Doug supervising INDEPTH-III field operations from the running-board of his field vehicle,
on the banks of Siling Tso, central Tibet, summer 1998.
Memorial for Doug Nelson

Doug Nelson, the Jessie Page Heroy Professor of Earth Sciences and Department Chair at Syracuse University, died as he was reaching new heights in an increasingly distinguished career. His sudden and untimely death from heart failure robbed us all of many insights and papers that would have been forthcoming in decades still to come. His most visible legacy is a new understanding of Tibet, resulting in large part from the work that he led and supervised as the intellectual leader of the INDEPTH (International Deep Profiling of Tibet and the Himalaya) program.

Doug graduated from Cornell University with a BS in 1975. He received his PhD as a structural geologist working on the Newfoundland Appalachians from SUNY Albany in 1979, at a time when that department stressed the continuum from field observations to plate-tectonic synthesis. After a brief post-doctorate at Otago University, New Zealand, Doug returned to Cornell University to join COCORP (Consortium for Continental Reflection Profiling). There he learned to interpret deep seismic reflection data, and to value geophysics for the study of large-scale processes in mountain belts. Doug became a proponent of taking the COCORP methodology to the greatest of all mountain belts, the Himalaya.

When Doug first went to Tibet in the 1980s, even the basic crustal architecture was uncertain; for example, whether the plateau crust was thick because two normal crusts had been vertically stacked, or because a single crust had been thickened by pure shear. Doug used the pilot 1992 INDEPTH reflection profile across the Himalaya to show that the Indian foreland was subducting beneath southern Tibet along an active master detachment—named by Doug the Main Himalayan Thrust—to depths from which it could confidently be extrapolated to underthrust the Indus-Tsangpo suture. This result only fuelled speculation on the ultimate northward limit of penetration of Indian crust beneath Tibet, and the fate of the subducting continental crust in the suture zone. Doug had already addressed this mass-balance problem for the overthickened crust of other continent–continent collisions, arguing from reflection profiles for delamination in the Appalachians, but for a phase change at the Moho in the Trans-Hudson orogen.

The second and third INDEPTH field campaigns in 1994 and 1998 progressed into interior Tibet, and added to the original reflection profiling additional scientific techniques: wide-angle and refraction seismology, broadband teleseismic recording, magnetotelluric observations and field geology. Doug actively participated in all these separate programmes, and more than anyone was the enthusiastic integrator in the large multi-national group of investigators (from the USA, China, Canada and Germany), best able to synthesize seemingly disparate observations from all the techniques. Doug’s intellectual legacy includes a generation of students and colleagues, at Syracuse, Cornell and the other INDEPTH institutions, who now regard such broad interdisciplinary science as the norm.

The most serendipitous discovery of the INDEPTH project, and the most consequential, was the crustal melts in southern Tibet, recognized independently by all the geophysical techniques employed. Doug, by now professor at Syracuse University, pushed forward studies on the structure of the suture zone that, he believed, could be regarded as a region of mixing of the crusts of India and Tibet, which then extruded towards India, crystallizing as leucogranites now exposed at the erosional front of the High Himalaya. Doug’s recognition of partial melting in interior Tibet implied at once that this region is hot, and hence mobile. Much of the recent popularity of models of continent–continent collisions in which material transport is dominated by middle and lower crustal flow must be attributed to observations such as these that bear directly on crustal viscosity. Though such flow is now widely accepted, this is only a recent paradigm shift.

Doug was a master of his trade, able to integrate his training as a field geologist with the big picture drawn from his regional geophysical surveys. Although he did not live to write a final synthesis of the INDEPTH results, our picture of Tibet and hence of all continent–continent collisions has changed and grown far richer, a legacy that enriches the Earth Sciences community.

Simon Klemperer
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