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The Himalayan Seismogenic Zone: A New Frontier for Earthquake Research

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The Mw 7.8 Gorkha, Nepal, earthquake that occurred on April 25 of this year was a dramatic reminder that great earthquakes are not restricted to the large seismogenic zones associated with subduction of oceanic lithosphere. Not only does Himalayan seismogenesis represents important scientific and societal issues in its own right, it constitutes a reference for evaluating general models of the earthquake cycle derived from the studies of the oceanic subduction systems. This presentation reports results of a Mini-Workshop sponsored by the GeoPrisms project that was held in conjunction with the American Geophysical Union on December 15, 2015, designed to organize a new initiative to study the great Himalaya earthquake machine.

The Himalayan seismogenic zone shares with its oceanic counterparts a number of fundamental questions, including:
a) What controls the updip and downdip limits of rupture?
b) What controls the lateral segmentation of rupture zones (and hence magnitude)?
c) What is the role of fluids in facilitating slip and or rupture?
d) What nucleates rupture (e..g. asperities?)?
e) What physical properties can be monitored as precursors to future events?
f) How effectively can the radiation pattern of future events be modeled?
g) How can a better understanding of Himalayan rupture be translated into more cost effective preparations for the next major event in this region?

However the underthrusting of continental, as opposed to oceanic, lithosphere in the Himalayas frames these questions in a very different context:
h) How does the greater thickness and weaker rheology of continental crust/lithosphere affect locking of the seismogenic zone?
i) How does the different thermal structure of continental vs oceanic crust affect earthquake geodynamics?
j) Are fluids a significant factor in intercontinental thrusting?
k) How does the basement morphology of underthrust continental crust affect locking/creep, and how does it differ from the oceanic case?
l) What is the significance of blind splay faulting in accommodating slip?
m) Do lithologic contrasts juxtaposed across the continental seismogenic zone play a role in the rheological behavior of the SZ in the same manner as proposed for the ocean SZ?

Major differences in the study of the continental vs oceanic seismogenic zone include the fact that Himalaya structures are open to:
a) direct geological observation via field mapping
b) dense and wide aperture monitoring of surface strain via GPS and INSAR
c) extensive sampling of geofluids via surface flows and shallow drill holes
d) cost effective deployment of long term geophysical arrays (e.g. seismic and MT) designed to detect subtle variations if physical properties within the seismogenic zone, and ultimately,
e) a fixed platform for deep drilling of past and future rupture zones

It remains to be established whether the Himalayan seismogenic zone has the potential for earthquakes of the greatest magnitudes (e.g. 9.0+). However, there is no question that future ruptures in this system represent a

serious threat to major population centers (megacities) in the Indian subcontinent. For this reason alone the HSZ is deserving of a major new international, multidisciplinary effort.