Chronostratigraphic Constraints on the Inner Lesser Himalayan Sedimentary belt of North India, and Proterozoic Sediment Continuity of the North Indian Margin

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In northern India the Lesser Himalaya lithotectonic unit is divided into two sedimentary belts referred to as the "inner" and "outer" Lesser Himalaya (iLH & oLH, respectively). However, the relationship between these units is problematic, primarily due to a poor understanding of the stratigraphic architecture and age of the iLH. The chronostratigraphy of the majority of oLH strata is well established and the system can be broadly divided into four major units, in ascending order, the Neoproterozoic Jaunsur/Simla Group, the Cryogenian Blaini Formation, the Ediacaran Krol Group, and the Cambrian Tal Group. The Blaini diamictite has been correlated to the Marinoan Glaciation (ca. 635 Ma) with base of the carbonate-dominated Krol Group marked by the corresponding cap-carbonate, and both the chemostratigraphy and lithostratigraphy of the Krol are remarkably similar to the Ediacaran Yangtze Platform of South China (Jiang and others, 2003). The siliciclastic dominated Tal Group contains Cambrian metazoan macrofossils (Hughes and others, 2005). The iLH can be broadly divided into three major units, the quartzite dominated Berinag, the mixed siliciclastic Damtha, and the carbonated dominated Deoban Groups, although the ages and stratigraphic relationships of these strata are currently unconstrained. The Deoban Group is well known to overlie the Damtha Group, but the Berinag Group has been suggested to sit either below the Damtha Group as the lowermost unit of the iLH (Richards and others, 2005), or above the Deoban Group as the uppermost unit of the iLH (Valdiya, 1980). This issue is greatly complicated by a lack of geochronologic data. For instance, the Deoban Group was originally assigned a "Riphean" (Mesoproterozoic) age (Valdyia, 1980), an age broadly supported by geochemical data (Ahmad and others, 2000), yet recent reports of Ediacaran-Cambrian fossils have been used to argue for significantly younger ages for these strata (e.g., Tiwari & Pant 2009).

Our investigations of new U-Pb detrital zircon geochronology, sedimentology, and microfossil paleobiology of iLH strata in the Gahwal-Kumaon regions of northern India helps resolve some of these issues. Strata from the Berinag Group yielded distinctive detrital zircon spectra with a single dominant peak at ~1880 Ma and no grains younger than ~1800 Ma, similar to the results from the Berinag-Rampur Formation from the Sutlej Valley to the west (Richards and others, 2005). Damtha Group strata yielded broader spectra with peaks at 1600-1700 Ma, 1880 Ma, and 2500 Ma, with the youngest grain ~1600 Ma. These contrasts with a spectrum from the definitive Neoproterozoic Blaini Diamictite that shows similar peaks to Damtha Group, but includes a large number of younger grains around ~900 Ma and a youngest grain ~770 Ma. Given that all recent spectra from Cambrian siliciclastic rocks from the Himalaya contain high concentrations of relatively young material (Myrow and others, in press), the Berinag-Damtha groups are likely significantly older than the Blaini Diamictite. The Berinag-Damtha zircon spectra are remarkably similar to that from the Kuncha Formation and overlying strata of the Lower Nawakot Unit of Nepal (Martin and others, 2005). Damtha spectra are also similar to the Shumar Formation of Bhutan (McQuarrie and others, 2008), which suggests that these strata were all part of the laterally contiguous late Paleoproterozoic north Indian margin. The spectra also support a model in which the Berinag Group is the lowermost unit of the iLH, in agreement with the Richards and others (2005) model. K-S statistical analysis of Blaini Diamictite grains older than 1600 Ma and the Damtha Group showed no significant differences between these populations, suggesting both the oLH and iLH were deposited in a single continuous margin with the Blaini receiving more ancient sediment from either reworked Damtha strata, similar primary sources, or a combination of the two.

Reviews of published material and our independent research of fossiliferous material from the Deoban Group show no evidence for an Ediacaran–Cambrian age assignment. Phosphatic *Baicalia* stromatolites in the Gangolihat Dolomite (i.e., Deoban Group) yielded three-dimensionally preserved organic-walled microfossils and microbial textured intraclasts with gas bubbles preserved within the microbial fabrics.

This lithologically distinct deposit is identical to those in the Tirohan Dolomite in the Vindhyan Basin from central India, which have been dated at ~1600 Ma (Bengtson and others, 2009). The lithological similarity between these units, and the fact that the youngest detrital zircon from strata directly underlying the Gangolihat Dolomite is ~1600 Ma, suggest these are age-equivalent deposits that were part of a large epicontinental platform that covered the north Indian margin during the late Paleoproterozoic to early Mesoproterozoic. The potential continuity between the Vindhyan Basin and the Himalayan margin contrasts with the current view that Vindhyan sediment was deposited in an intracratonic basin isolated from the rest of the north Indian margin (e.g., Bose and others, 2001).

References

Amhad, T., and others, 2000, Isotopic constraints on the structural relationships between the Lesser Himalayan Series and the High Himalayan Crystalline Series, Garhwal Himalaya, Geol. Soc. Am. Bulletin, 112, 467-477.

Bengtson, S., Belivanova, V., Rasmussen, B. and Whitehouse, M., 2009, The controversial "Cambrian" fossils of the Vindhyan are real, but more than a billion years older, Proc. Nat. Acad. Sci., 106, 7729-7734.

Bose, P.K., Sarkar, S., Chakrabarty, S. and Banerjee, S., 2001, Overview of the meso- to Neoproterozoic evolution of the Vindhyan Basin, central India, Sedimentary Geology, 141, 395-419.

Hughes, N.C., and others, 2005, Cambrian biostratigraphy of the Tal Group, Lesser Himalaya, India, and early Tsanglangpuan (late early Cambrian) trilobites from the Nigali Dhar syncline, Geol. Mag., 142, 57-80.

Jiang, G., Sohl, L.E. and Christie-Blick, N., 2003, Neoproterozoic stratigraphic comparison of the Lesser Himalaya (India) and Yangtze block (south China): Paleogeographic implications, Geology, 31, 917-920.

Martin, A.J., DeCelles, P.G., Gehrels, G.E., Patchett, P.J. and Isachsen, C., 2005, Isotopic and structural constraints on the location of the Main Central thrust in the Annapurna Range, central Nepal Himalaya, Geol. Soc. Am. Bulletin, 117, 926-944.

McQuarrie, N., and others, 2008, Preliminary stratigraphic and structural architecture of Bhutan: Implications for the along strike architecture of the Himalayan system, Earth Planet Sci. Letts., 272, 105-117.

Myrow, P.M., and others, in press, Extraordinary transport and mixing of sediment across Himalayan central Gondwana during the Cambrian-Ordovician, Geol. Soc. Am. Bulletin.

Richards, A., and others, 2005, Himalayan architecture constrained by isotopic tracers from clastic sediments, Earth Planet Sci. Letts., 236, 773-796.

Tiwari, M. and Pant, I., 2009, Microfossils from the Neoproterozoic Gangolihat Formation, Kumaun Lesser Himalaya: Their stratigraphic and evolutionary significance, J. Asian Earth Sci., 35, 137-149.

Valdiya, K.S., 1980, Geology of Kumaun Lesser Himalaya, Wadia Institute of Himalayan Geology Dehra Dun, India, p. 291.

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