

(summer) and dark (winter) bands (page 63, para 2) be resolved? More confusing is the oxygen isotopic estimation of Goting lake water that, according to them, is close to snow and river water and deviates significantly from the glacial meltwater. I am at loss to understand this interpretation. The river water at Goting is nothing but the glacial melt only. It would have been better and closer to reality if the estimates were based on the meltwater samples provided to them from Goting basin. It has been suggested that $\delta^{13}\text{C}$ of Goting carbonate mimic the marine carbonate and negative excursions are attributed to soil CO_2 . First, barring a few there are no major excursions that can be attributed to soil CO_2 and the dominant fluctuations are between -2‰ and 1‰ (figure 3b). Even if I presume the interpretation is correct, this does not go with the field observation considering the terrain that is devoid of vegetation and no soil profiles were found. Hence, it can be inferred that condition during the existence of the lake would have been much severe in terms of soil development.

(8) The authors have used the location map of Goting basin (figure 1, page 60) from our earlier publication without any reference to it. Figure 2 (page 61) is still more shocking as it is neither from Goting nor does it show varves. The figure shows soft sediment deformations at Garbyang en route to Kailash–Mansarovar that has been published to our surprise without our knowledge and consent.

1. Ghosh, P. and Bhattacharya, S. K., *Curr. Sci.*, 2003, **85**, 60–67.
2. Pant, R. K., Juyal, N., Rautela, P., Yadav, M. G. and Sangode, S. J., *Curr. Sci.*, 1998, **75**, 850–855.
3. Juyal, N., Pant, R. K., Basavaiah, N., Yadava, M. G., Saini, N. K. and Singhvi, A. K. *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 2003 (in press).
4. Krishnaswami, S. and Lal, D., In *Lakes: Chemistry, Geology and Physics* (ed. Abraham Lerman), Springer-Verlag, New York, 1978, pp. 153–177.
5. Geyh, M. A., Schotterer, U. and Grosjean, M., In *Proceedings of the 16th International ^{14}C Conference, Radiocarbon*, 1998, pp. 921–931.
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Response:

Our paper (G.B.)¹ is based on an earlier study by Pant *et al.* (R.K.P.)² discussing the geological aspects of sediments from the Goting palaeo-lake and their chronology. Here we address the relevant issues raised by the present comments.

(1) According to R.K.P., formation of the Goting lake is related to the Trans-Himadri Fault leading to creation of the Khal Kurans Ridge acting as a geomorphic barrier for the glacial moraines to accumulate and make the pro-glacial lake. A redistribution of moraines required to establish the blockage was possibly caused by earth movement (probably due to re-activation of the fault) or landslide. However, our data and interpretation do not depend on how the lake was formed.

(2) Goting basin is located close to Mukteswar which receives substantial amount of monsoon rain. In the absence of meteorological data from any station in the Goting basin we used IMD data from Mukteswar. It is not reasonable to claim that Goting basin does not experience monsoon just because it lies in the rain shadow zone without support from meteorological data.

(3) Our study is based on the premise that major part of the carbonate is micritic. We do not agree that all calcite grains are detrital. Pant's comment itself mentions that bigger calcite grains are embedded in 'calcareous matrix' which are nothing but fine-grained carbonates.

(4) The chronology used in our paper is based on that given by R.K.P. We have discussed and used the age data with necessary correction. The new luminescence dating data mentioned is still not published. It is obvious that any change in the chronology will affect the interpretation.

(5) To explain the genesis of light and dark bands we examined, their composition and observed large oxygen isotopic depletion in the light band (summer band) relative to the dark band. This is caused by seasonal change in water composition. We also found that the river water resembles the snow rather than glacial melt water (depleted) in isotope ratio. This observation was used for interpretation. It is obvious that the glacial melt water is different in composition (probably due to its origin at higher altitude) from the river water. It is not correct to assume that 'the river water at

Goting is nothing but the glacial melt only'.

(6) Figure 2 in G.B. demonstrates the nature of the varves and the banding. The visual nature of this sample is exactly the same as other Goting samples. Figure 1 is a modified version of the detailed map published in R.K.P. to show the geographical features more clearly.

1. Ghosh, P. and Bhattacharya, S. K., *Curr. Sci.*, 2003, **85**, 60–67.
2. Pant, R. K., Juyal, N., Rautela, P., Yadav, M. G. and Sangode, S. J., *Curr. Sci.*, 1998, **75**, 850–855.

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Reply:

(1) The response by Ghosh and Bhattacharya¹ is self-contradictory. At the first place, G.B. appear to be emphatic on attributing tectonics for the genesis of the lake and towards the end they reject the very question as they think it is irrelevant for the interpretation of their data. I am at loss to understand why the question of the genesis should at all be raked. It will be better to leave it to the specialists to debate and decide on whether it could be regarded as a 'proven fact' or not.

(2) I have already indicated in my rejoinder that the radiocarbon ages from the lake deposits in a carbonate terrain suffer from hard water effect hence are unreliable. Goting basin lies in the Tethyan Himalaya. Therefore, climatic inferences drawn based on radiocarbon chronology are bound to be misleading. Juyal *et al.* (ref. 3 in our previous correspondence) have proposed a new chronology based on the luminescence technique that has helped us assign ages to the initiation of the lake and time of its breaching in addition to defining the climatic and seismic events in a chronological order. G.B. is silent on their time series data that was questioned in the rejoinder. Does that mean that they have deliberately avoided answering it realizing the unreliability of radiocarbon dates?

(3) It was shocking to read that 'Goting basin is located close to Mukteswar'. In fact the basin is only 16 km south of the Indo-Tibetan water divide and may be not very far from the Dunde ice cap² across the international border in Tibet. Mukteswar is situated in district Nainital. The question is not of distances but of the validity of application of data from a meteorological station located in a climatic zone to interpret the isotopic results from a site situated in different climatic zone. It has been long realized that the Central Himalaya, creating one of the most impressive rain shadows on Earth³, has strong effect on regional climate. In case of Goting, the barrier of Nandadevi massif in the south creates a semi-arid to arid zone very close to the climate of south central Tibet in the north, that is guided by a different system.

(4) The thin section studies on oriented varve blocks were carried out in close collaboration with reputed carbonate sedimentologists. Results of the study were reviewed twice by the Project Monitoring Committee of the Department of Science and Technology that consist of eminent geologists in the country and a project completion report thereof was submitted.

However, the problem seems to lie in understanding the sedimentation processes involved in a proglacial lake envi-

ronment. In such an environment, the lakes are thermally stratified during the summer with warm water in the upper part (epilimnion) and colder water in the lower part (hypolimnion). During summer, cold glacial melt water with suspended sediment gives rise to heavy density current and deposition takes place at the lake bottom as underflow. These layers are light coloured and relatively coarse grained mostly representing surrounding lithology. In the present case it is the Tethyan lithology. During winters, melt water and the allochthonous sediment supply decreases, thermal stratification disappears and the lake becomes well mixed. Sedimentation of the fine suspended particles including the autochthonous and allochthonous organic debris then takes place. With the freezing of the surface water during winter any exchange between lake water and the atmosphere gets cut off. Consequently, available dissolved oxygen is gradually depleted at the expense of CO₂ thereby enhancing the preservation of organic content as dark, very fine-grained laminae. Another peculiarity of proglacial sedimentation is the sporadic occurrence of ice rafted debris that range in size from a couple of centimeters to few millimeters. Under the circumstances it is difficult to believe that no detrital material is incorporated

in the laminae. The photomicrograph supplied by us bears testimony to this. In addition to calcite grains the thin sections also show quartz, feldspar, mica flakes and some opaque minerals representing the surrounding lithology. It would have been better for G.B. to have provided thin section photographs for comparison. The isotopic data of G.B. becomes unreliable for palaeoclimatic interpretations considering the sedimentation processes involved and presence of detrital calcite.

(5) As regards figure 2, it was the responsibility of G.B. to check whether the photograph represents Goting varves or not before it was submitted for publication and that should have been duly acknowledged. In case of figure 1, G.B. should have mentioned in the text that it is modified after Pant *et al.* as is customary in scientific writing.

1. Ghosh, P. and Bhattacharya, S. K., 2004, **86**, this issue.
2. Thompson, L. G. *et al.*, *Science*, 1989, **246**, 474-476.
3. Hodges, K. V., *GSA Bull.*, 2000, **112**, 324-350.

R. K. PANT

NEWS

Relevance of GM technology

A two-day national symposium on 'Relevance of GM Technology to Indian Agriculture and Food Security' was organized by Gene Campaign on 26 and 27 November 2003 in Delhi, to celebrate its 10th anniversary.

The multistakeholder symposium brought together speakers and participants with varied range of views on GM crops. Speakers ranged from strong supporters of GM technology to those equally strongly opposed to it, and those with meas-

ured views. One thing that all speakers pointed out was the appalling state of the Regulatory Framework in India and the urgent need to revamp it. Members of the Genetic Engineering Approval Committee (GEAC), India's apex regulatory body, explained the process of regulation and, in the face of vociferous demand, agreed to put more data on the GEAC website. A series of recommendations emerged from the two-day consultations.

For highlights of the presentations made during the symposium, Gene Campaign's website: www.genecampaign.org may be visited. Queries may be sent by e-mail to genecamp@vsnl.com.

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