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Conference on Milankovitch cycles over the past 5 million years

22 - 24 March 2007

Indian Monsoons

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& Research on Himalayan Glaciology

MULTI-PROXY EVIDENCES OF CLIMATE CHANGE FROM MIDDLE MIOCENE TO HOLOCENE IN NW HIMALAYA

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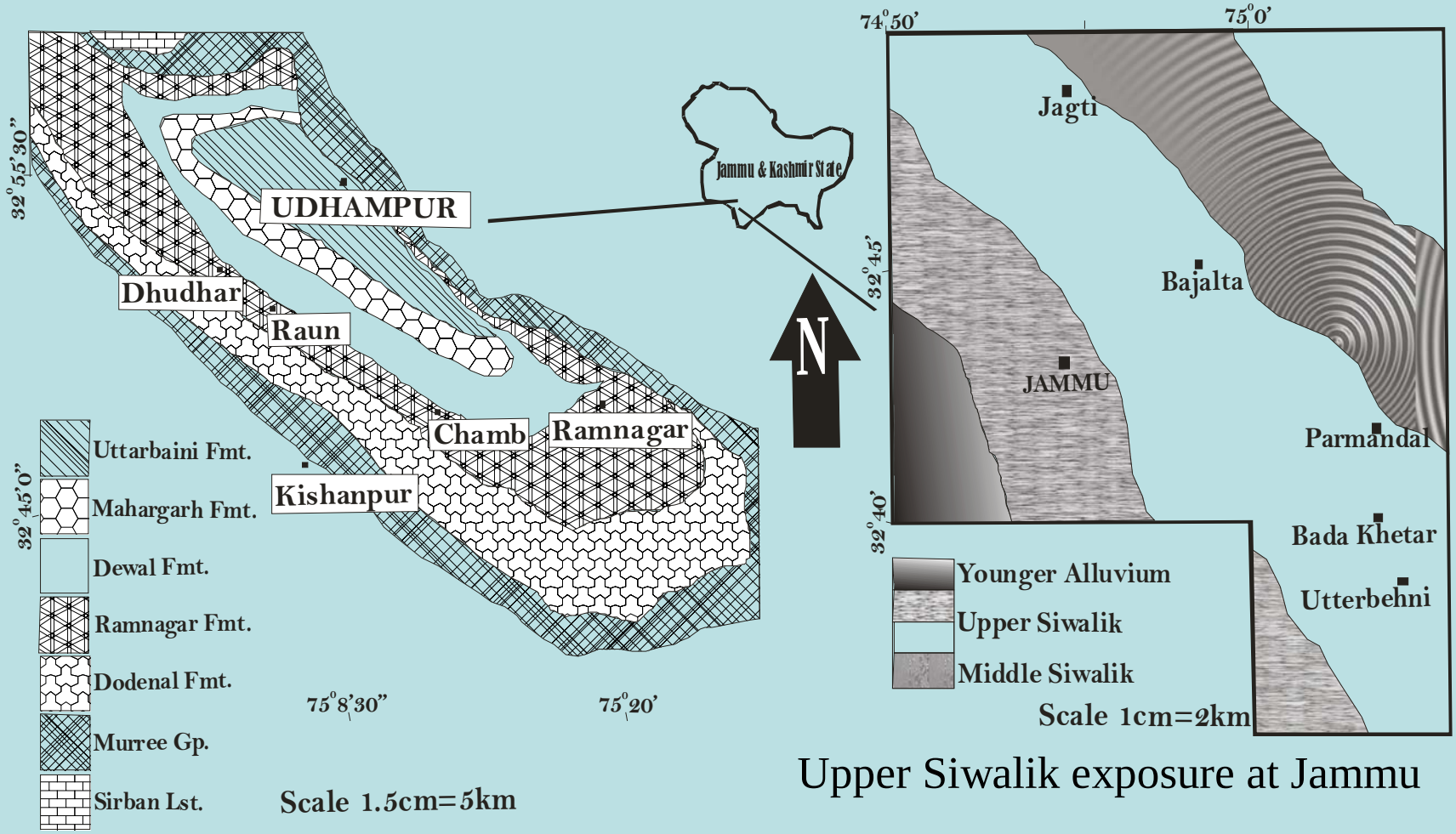
Part of Northwest Himalaya. Area of study marked in red.

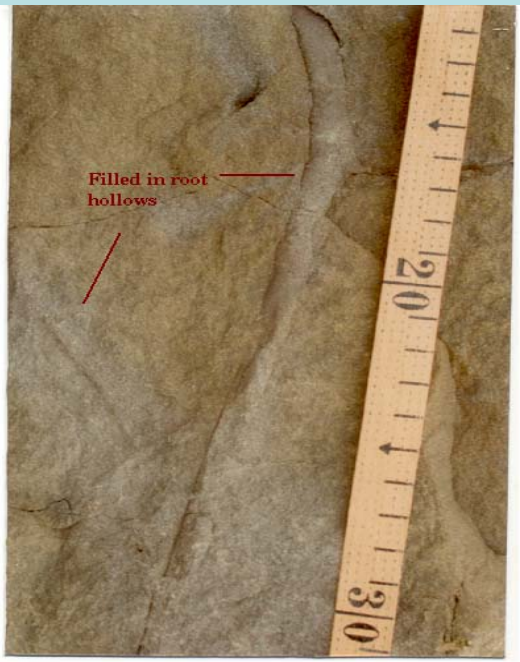


Lower Siwalik exposure at Jammu

Upper Siwalik exposure at Jammu

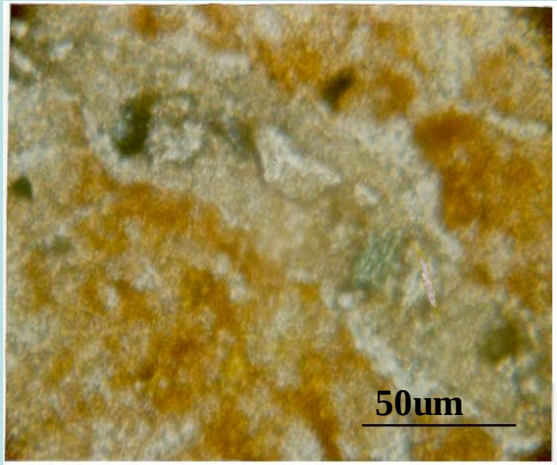
Variegated colour bands in the siltyclay sediments

Close up of above

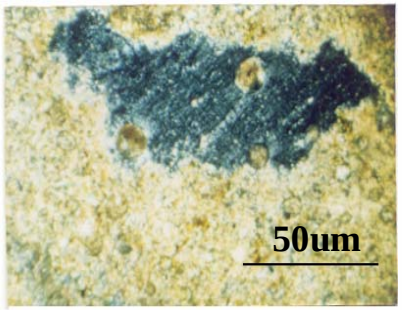


Filled in root hollows running perpendicular to bedding plane

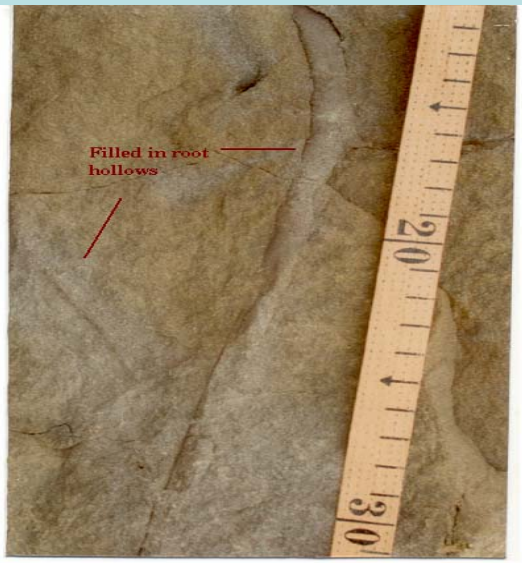
Trough cross-stratified medium grained sandstone with gravels along the foreset (scale 30 cm)



Photomicrograph of bone fragment showing first order interference of colours (under XPL)



Photomicrograph of kaolinite alteration. Note the alteration, within the mineral, is in parallel lines (under XPL)



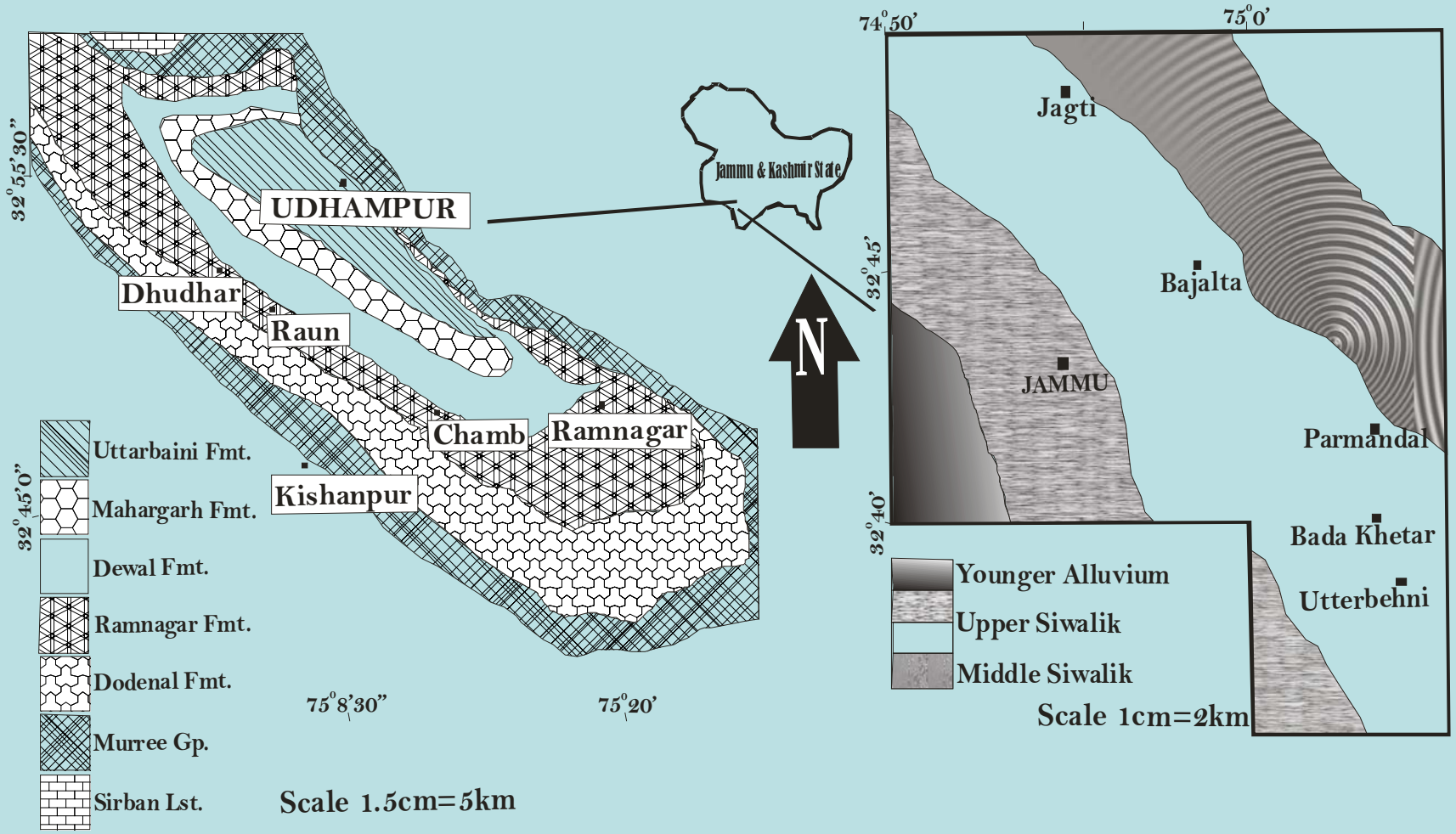
Root/burrows filled in with secondary material

Photomicrograph of stipple speckled b-fabric feature (under XPL)

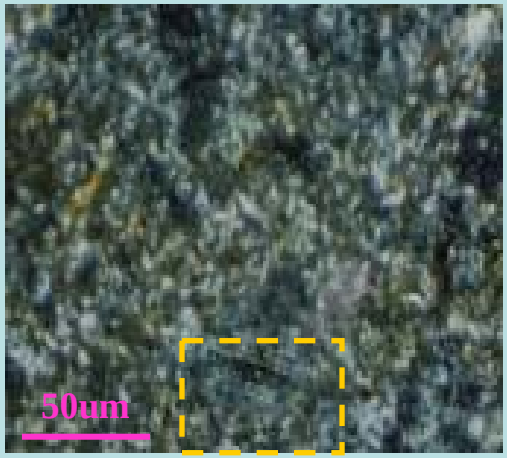
Lower Siwalik 13-10myr

- The deposits of Chinji Formation is formed as result of braided channels;
- Argillisol and gleysol are formed in crevasse - splay and floodplains;
- The soils formed during Middle Miocene(13-10myr) are result of wet and humid climate with mean annual precipitation of 1035-1375mm and warm temperature (12.5-16.5^{0}C) conditions.

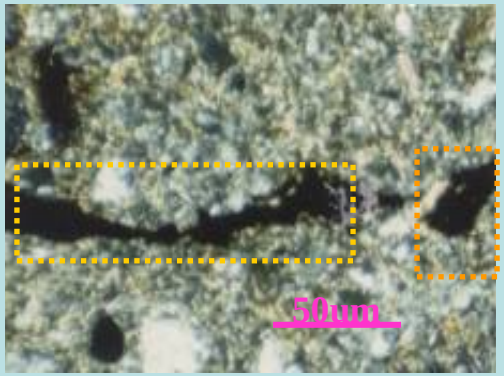
For details: **Journal of Asian Earth Sciences 2007, vol. 29, p. 704-714**



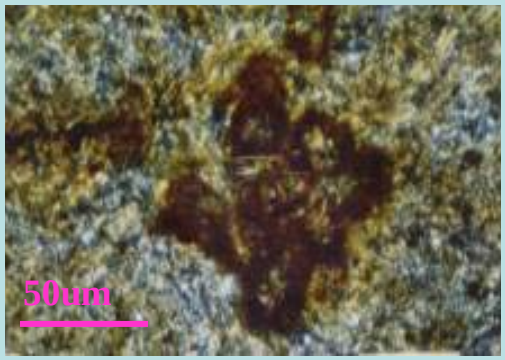
Geological Map of Upper and Lower Siwalik exposures at Jammu



Photomicrograph of halite crystal (boxed), underXPL



Photomicrograph of carbonised wood (boxed), under XPL

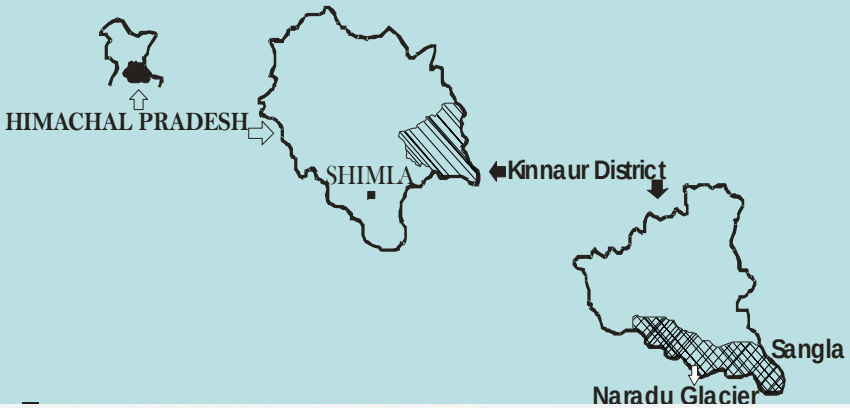


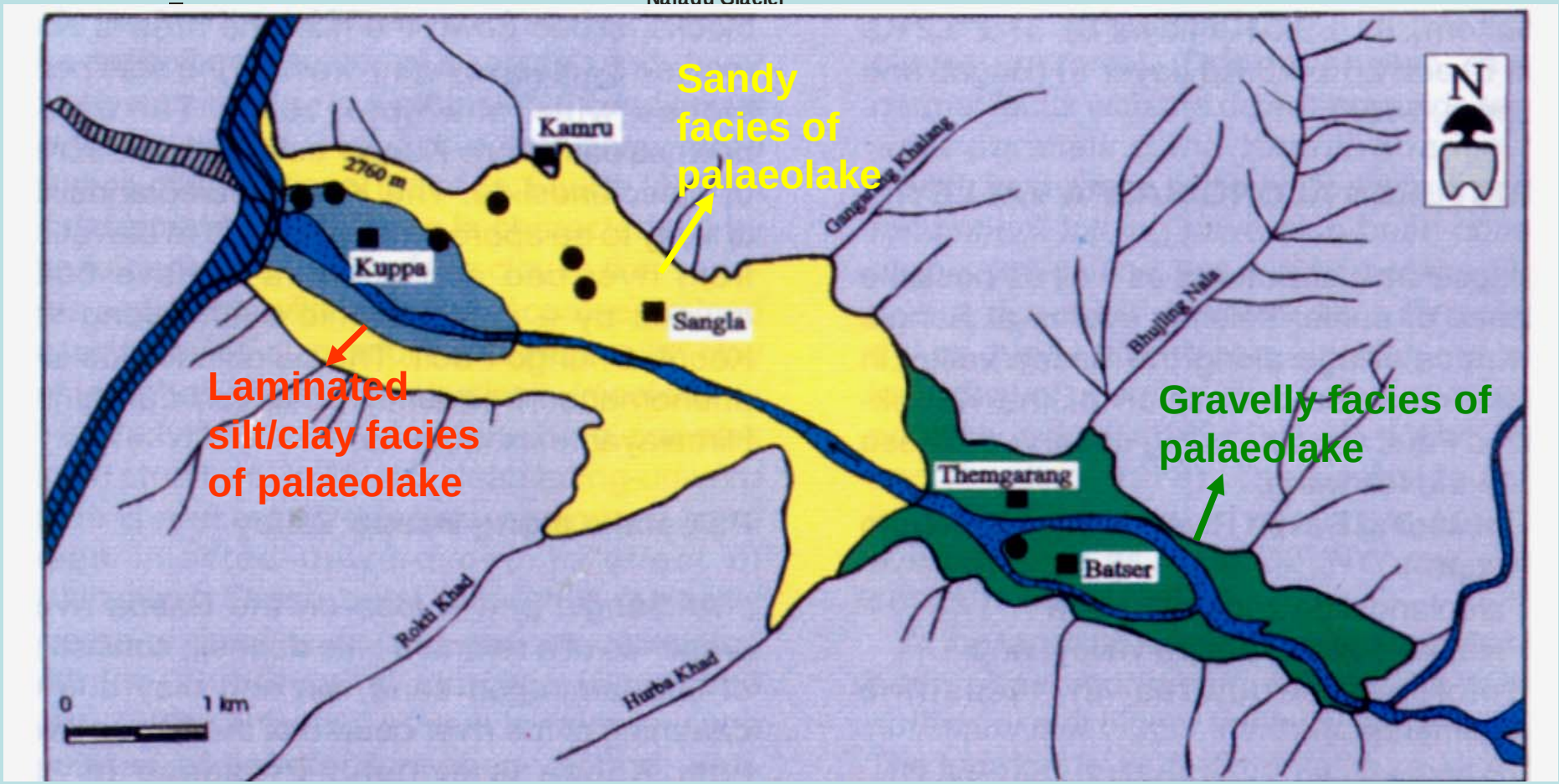
Photomicrograph of amoebiodal iron concentration, under XPL

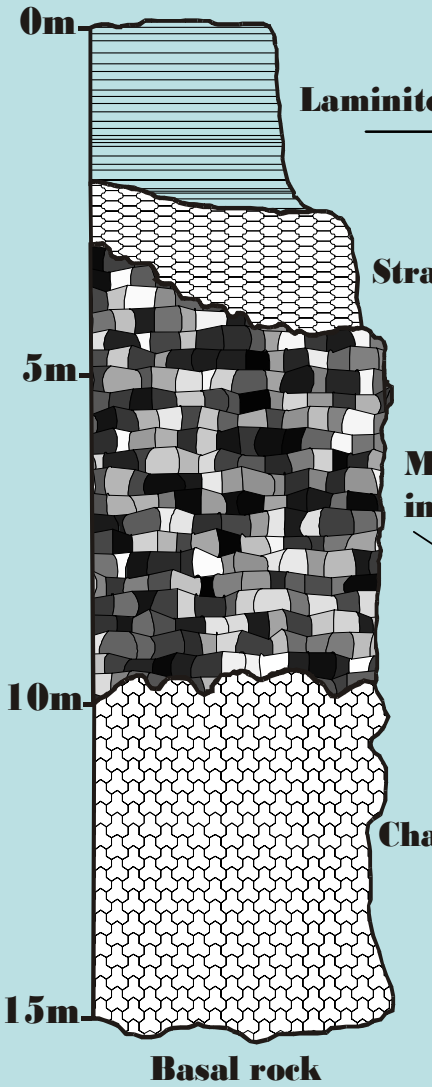
Upper Siwalik 2 – 0.4 myr

- The non-calcareous or weakly calcareous soils of Upper Siwalik are formed on mostly sandy/silty deposits formed due to lateral and downstream advance of channel bar;
- The gleysol is formed largely due to seasonally arid moisture realms with mean annual precipitation of 100 - 450mm and temperature 2^0C-16.6^0C ;
- Associated assemblage of grazing and browsing mammalian fauna further indicate existence of grassland habitat due to warm to mildly arid conditions.

For details **Zeitschrift fur Geomorphologie 2002, vol. 46(4), p. 441-453**


HIMACHAL PRADESH
SHIMLA
Kinnaur District
Sangla
Naradu Glacier


Sandy facies of palaeolake
Laminated silt/clay facies of palaeolake
Gravelly facies of palaeolake
Kamru
2760 m
Kuppa
Sangla
Gangaling Khalang
Bhujling Nala
Themgarang
Batser
Rokti Khad
Hurba Khad
N
0
1 km

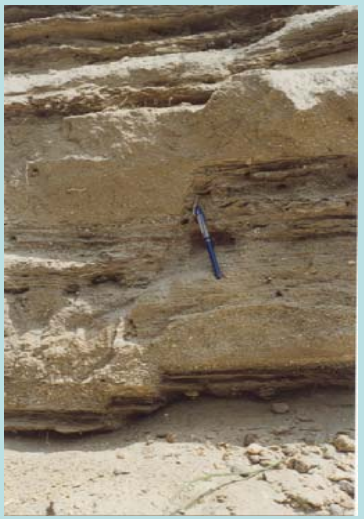


Laminites

Stratified fine sand/silt

Matrix rich, coarse tail, inverse/normal graded

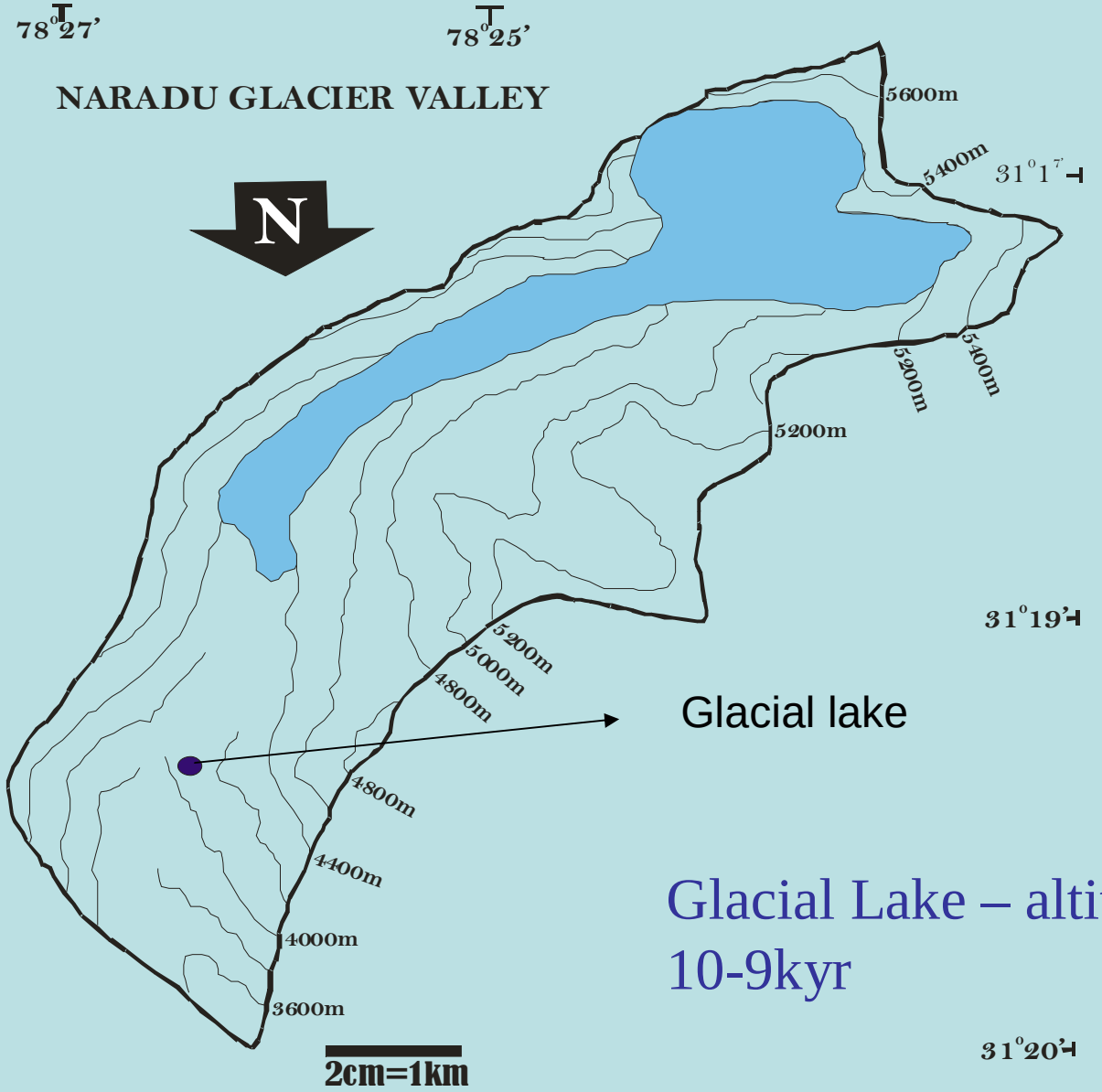
Chaotic colluvium



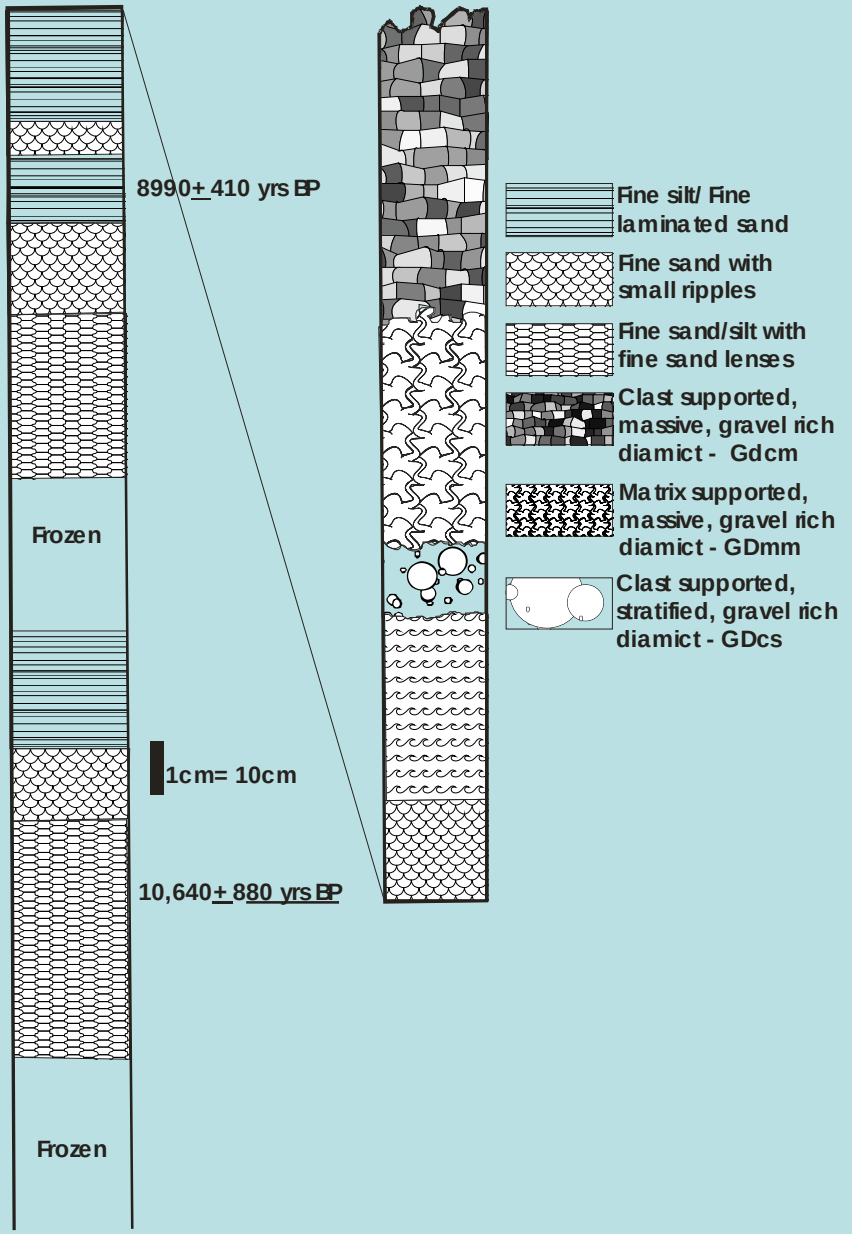
Sangla Valley 10-1kyr

- Warm and moist climate prevailed between 10,450 and 4310 yrs BP implying enhanced monsoonal activity;
- Reduction in precipitation and dominance of dry climate between 4310 and 1800 yrs BP;
- From 1800 to 1000 yrs BP the climate fluctuated between dry and wet phases;
- Lake desiccation occurred around 1000 yrs BP .

For details: **Current Science 2006, V. 91(6), p.777-782**
Journal of Earth System Science 2005, V. 114(4), p. 381-385



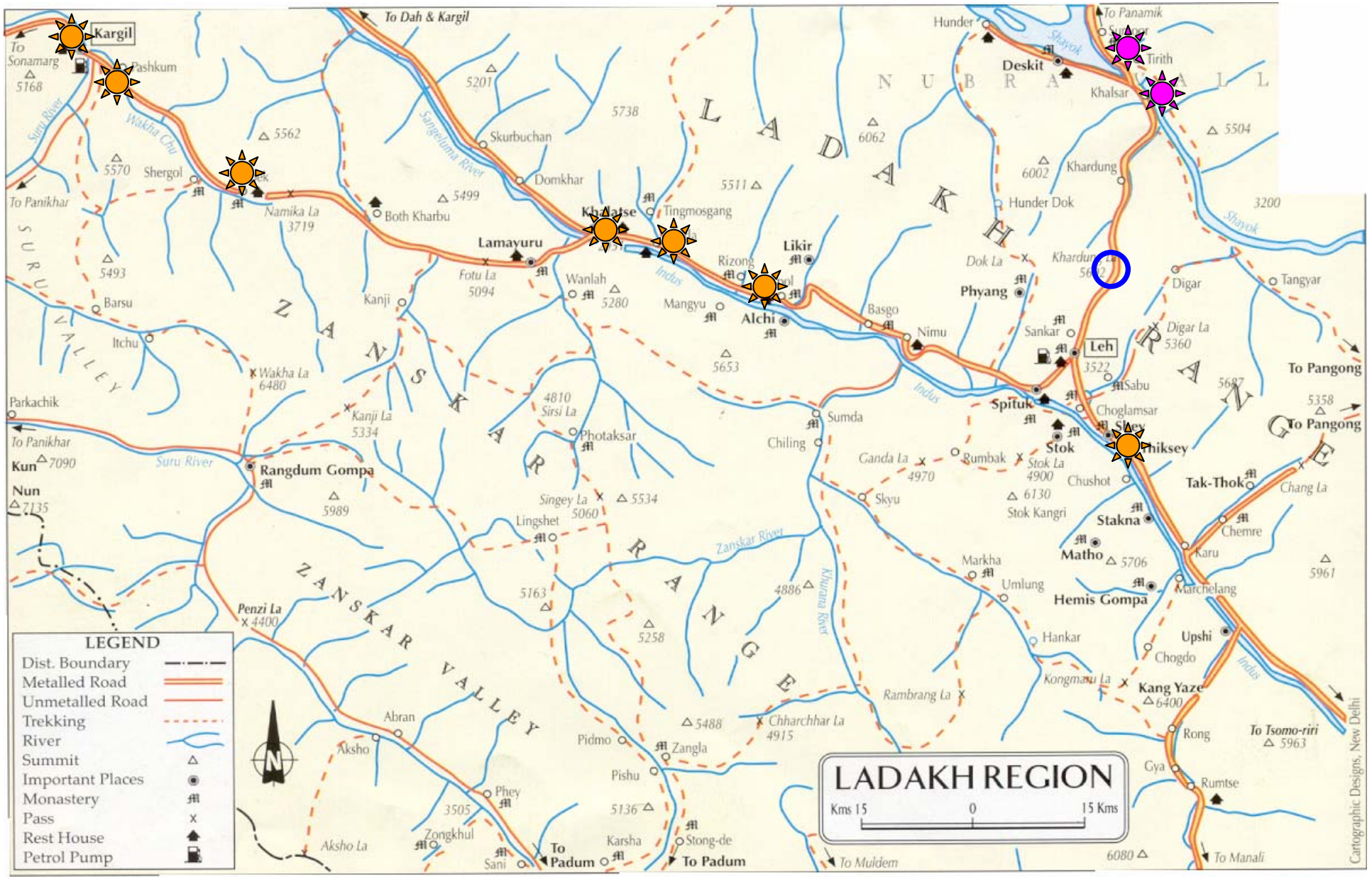
Glacial Lake – altitude 4025m asl
10-9kyr

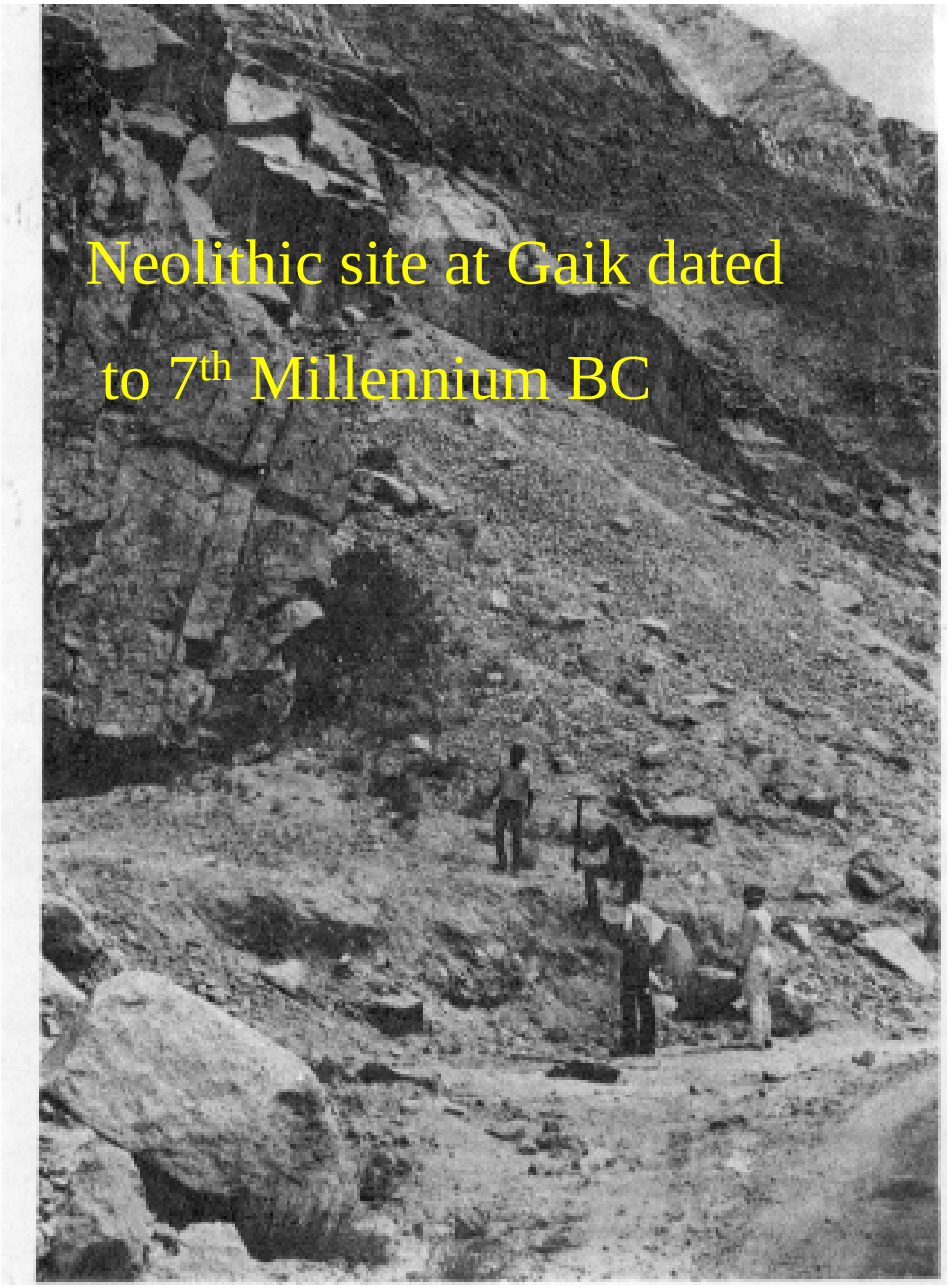

8990+ 410 yrs BP
Frozen
1cm= 10cm
10,640+ 880 yrs BP
Frozen
Fine silt/ Fine laminated sand
Fine sand with small ripples
Fine sand/silt with fine sand lenses
Clast supported, massive, gravel rich diamict - Gdcm
Matrix supported, massive, gravel rich diamict - GDmm
Clast supported, stratified, gravel rich diamict - GDcs

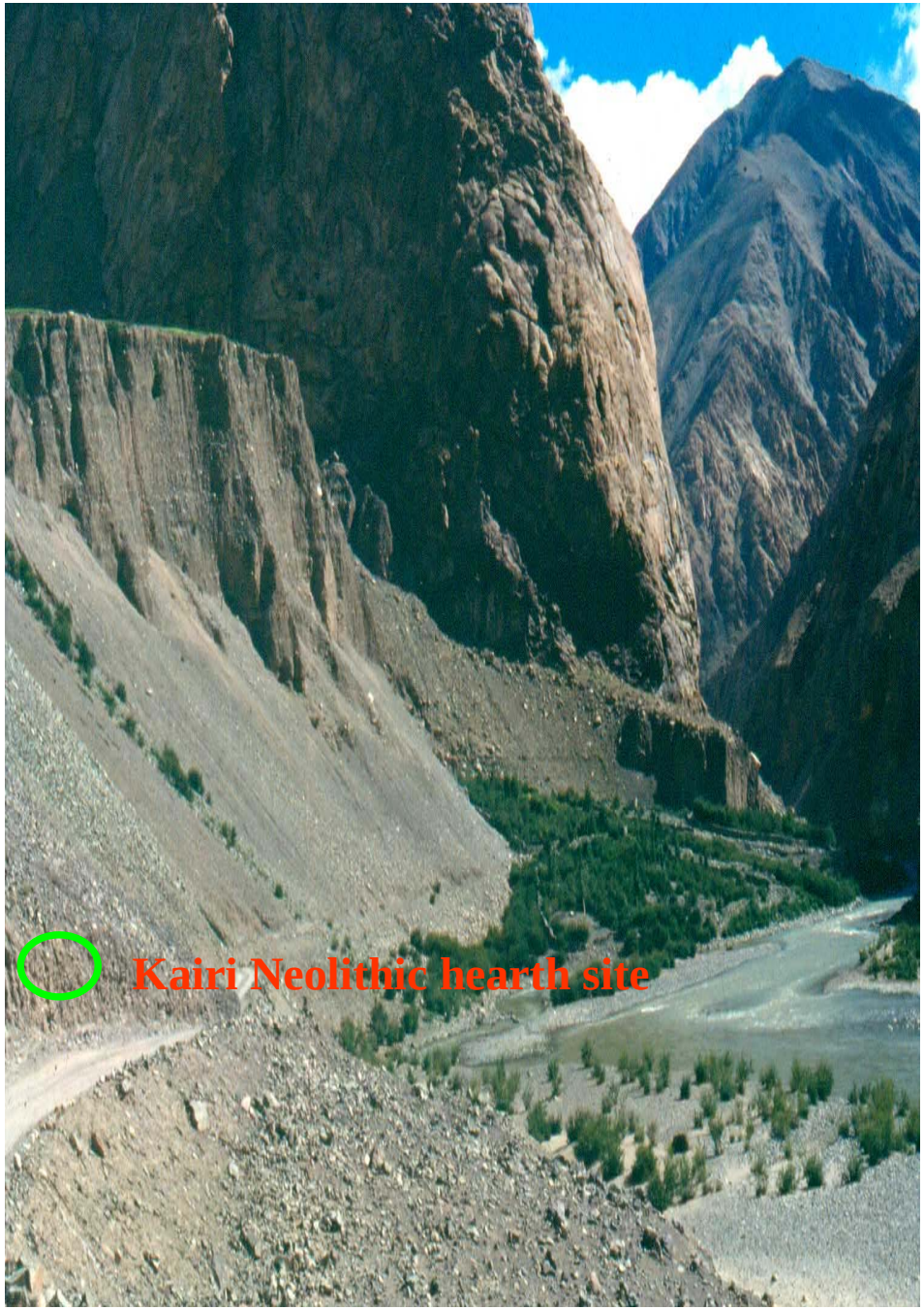
The 2.5 m deep profile covers a short period of Holocene ranging between 10,640 yrs BP to around 9,000 yrs BP. Palynological evidences suggest upward movement of forest cover under warm conditions. Fair values of Poaceae, Ranunculaceae, Saxifragaceae and other herbaceous taxa indicate the spreading of the local elements along the margin of the lake. Presence of Cheno/Ams and Ephedra towards the 9,000 yrs BP and lowering of broad leaved elements suggest of drier conditions

For details: The Palaeobotanist 2006, V.53, p. 89-96

Ladakh – Neolithic occupation




Neolithic site at Gaik dated
to 7th Millennium BC


Kairi Neolithic hearth site

For details *Current Advances in Indian Archaeology* Vol 1 1994 (R.K. Ganjoo & S.B.Ota Eds.), p. 111-127. Dattsons: Nagpur

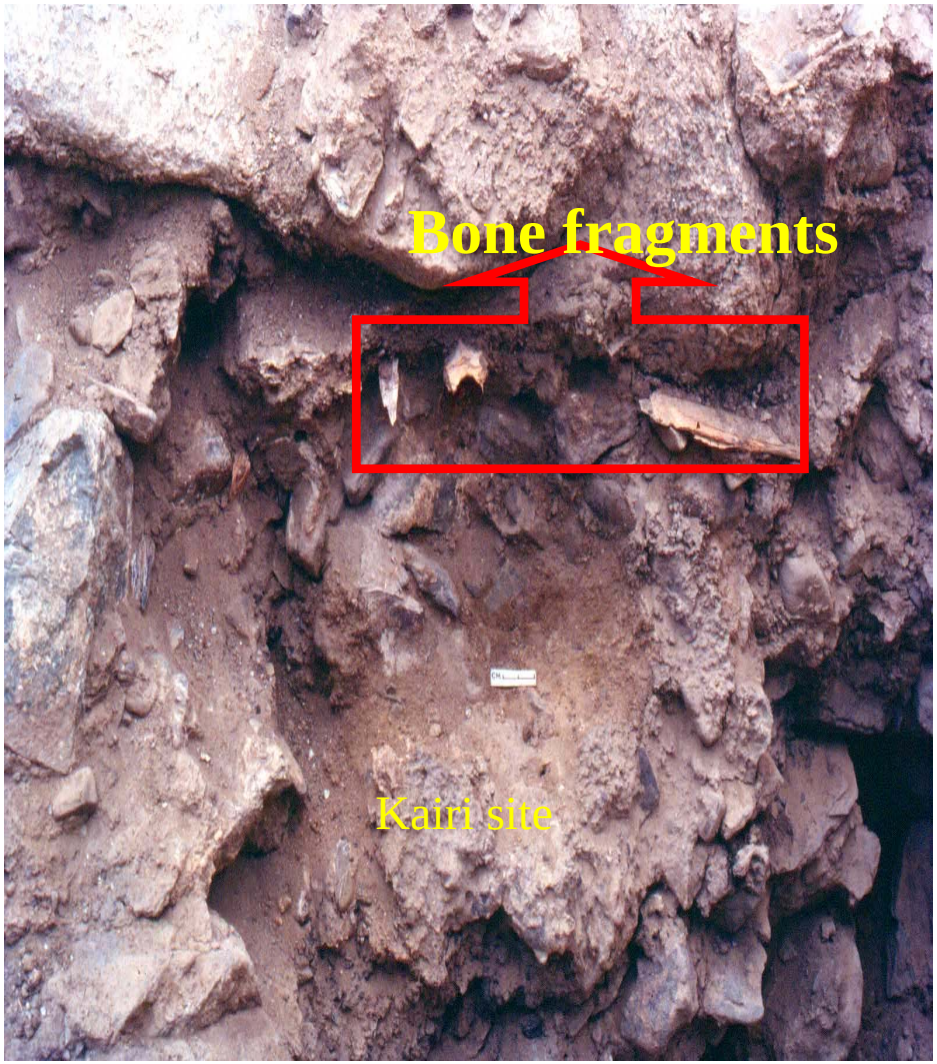
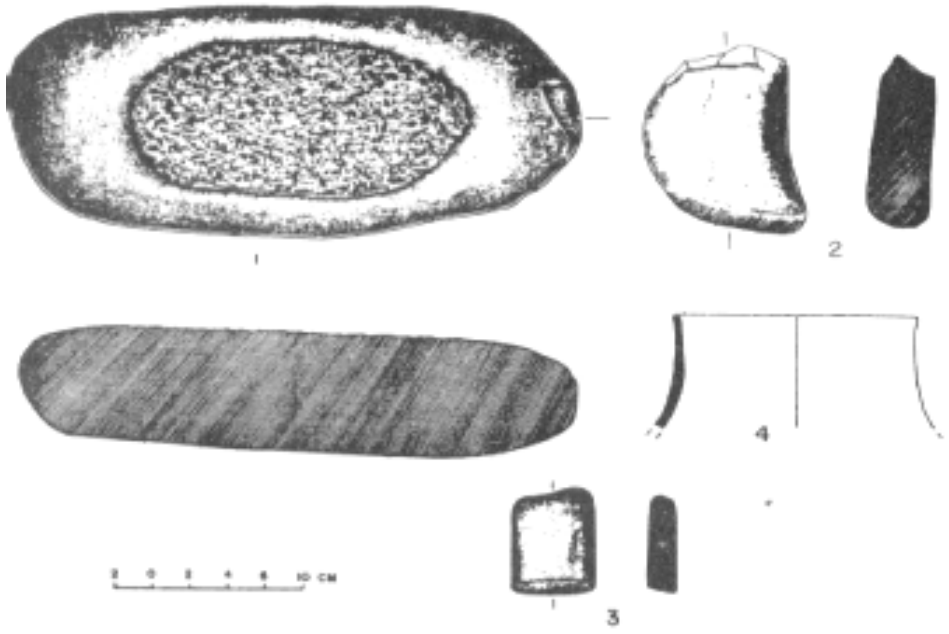
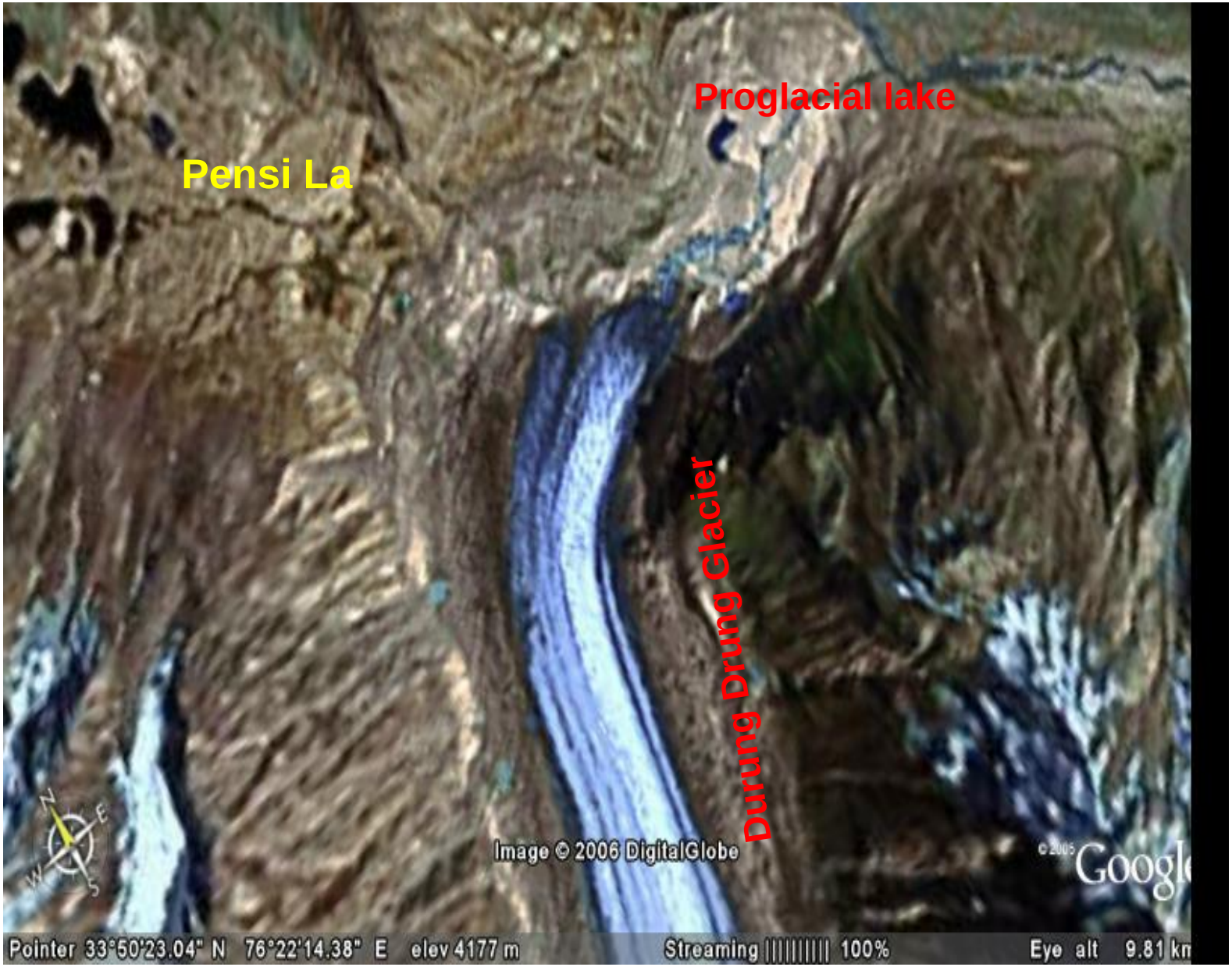


Fig. 4 : During exacavation of the site at Kiari.

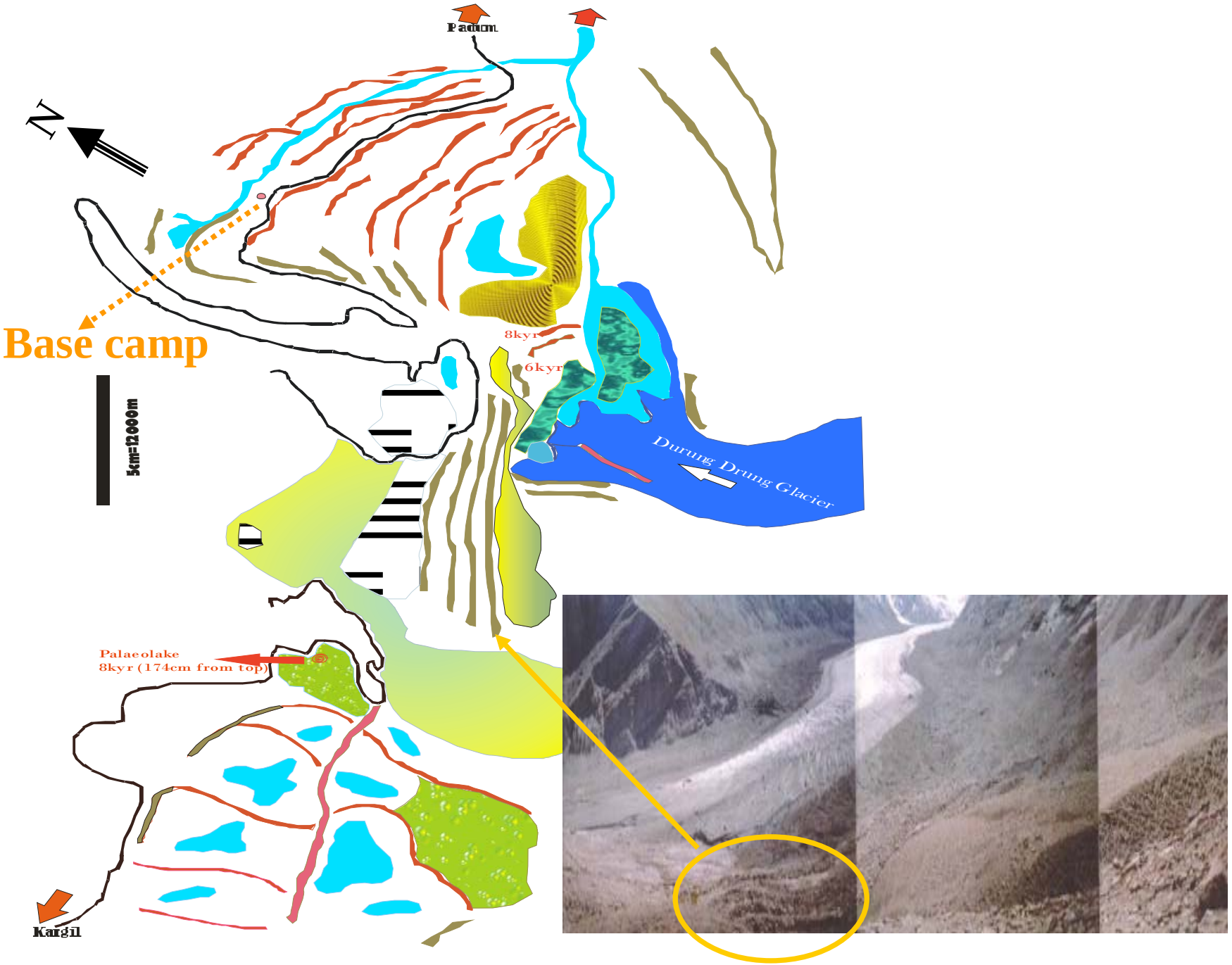


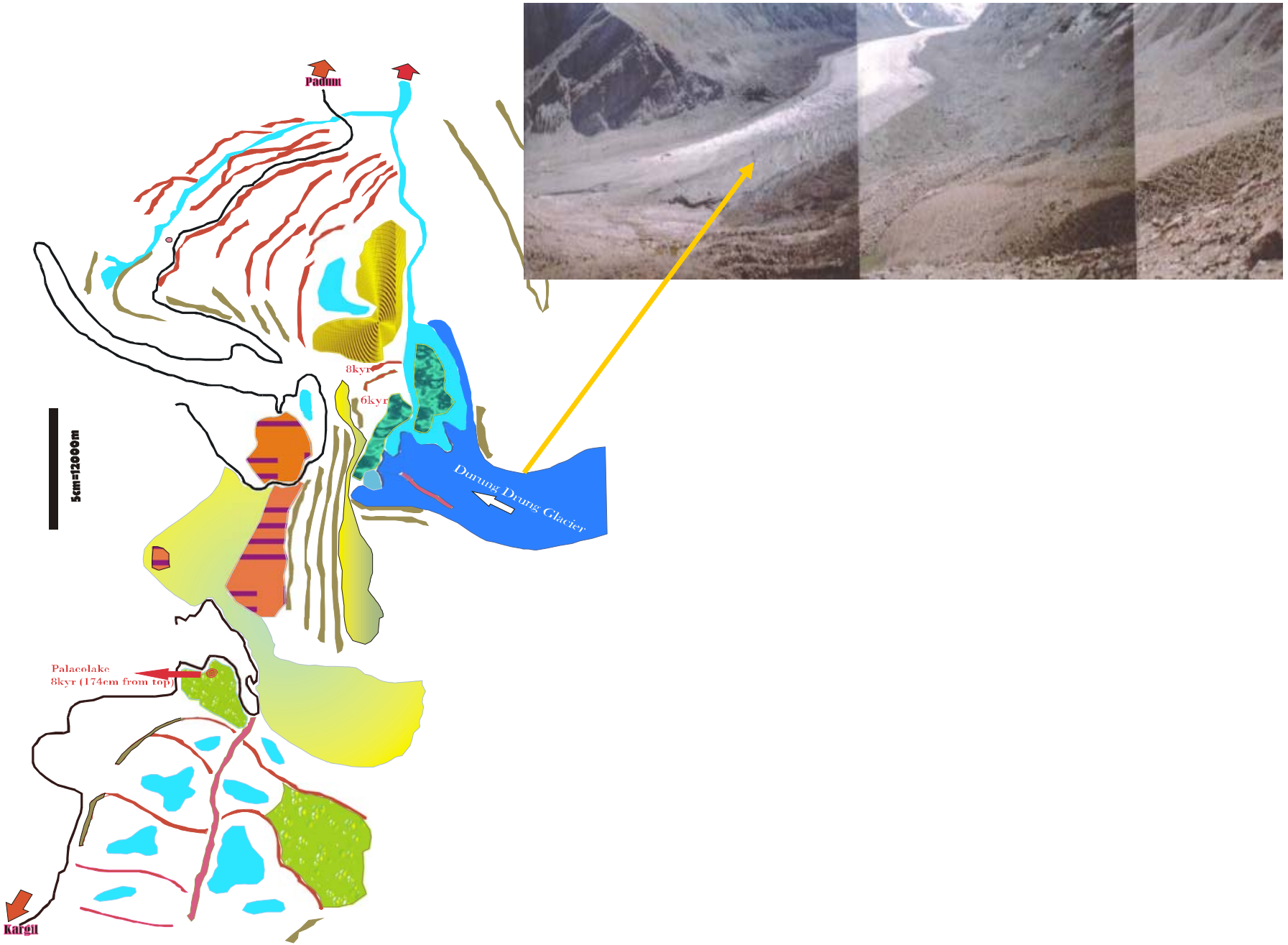
Kairi occupational site and associated cultural material

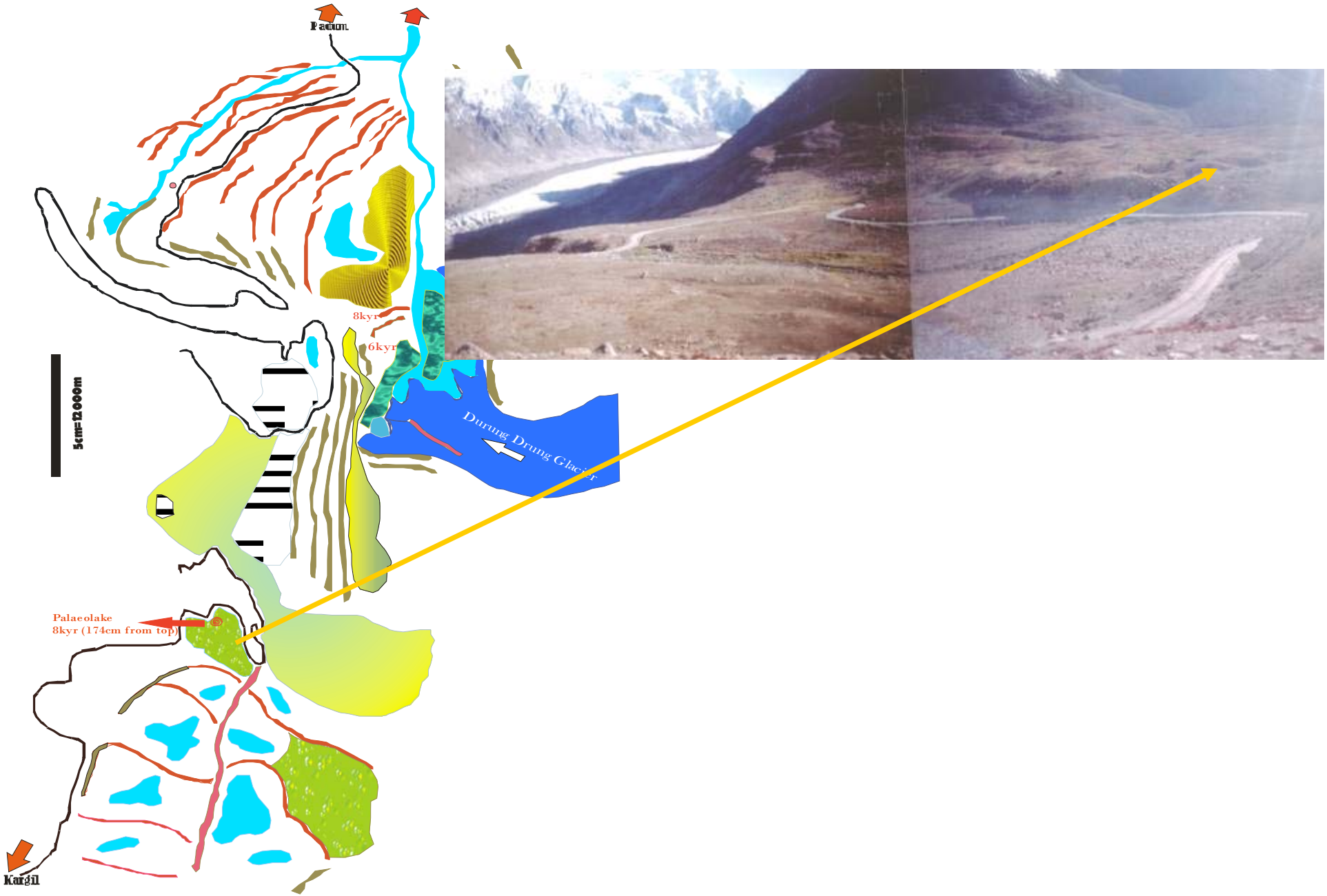
- The charred fragments of animal bones recovered from the site constitutes: *Bos* sp. (4%), *Capra* (27%), *Capra*/*Ovis*(5%), *Nemorhaedus goral* (2%), rodent (3%) and small ruminants (57%);
- The faunal assemblage suggests pastoral based economy supported with small hunting and gathering, as well;
- Charred animal bone fragments form 55.58% of the total faunal assemblage;
- The morphological features of post cranial bone fragments is slightly different and larger than that of the same species found in plain areas;
- Use of fire to char the animal bones for food purposes also point at the sufficient availability of fire wood in the surrounding in archaeological past which otherwise is a barren and vegetationless area today;
- There are five successive layers of hearth exposed in the terrace profile suggestive of repeated occupation of the terrace.


Proglacial lake
Pensi La
Durung Drung Glacier
Image © 2006 DigitalGlobe
Pointer 33°50'23.04" N 76°22'14.38" E elev 4177 m
Streaming 100%
Eye alt 9.81 km

General View of Durung Drung Glacier


Padum
N
Base camp
5km=12000m
8kyr
6kyr
Durung Drung Glacier
Palaeolake
8kyr (174cm from top)
Kargil


Padum
8kyr
6kyr
5cm=12000m
Durung Drung Glacier
Palaeolake
8kyr (174cm from top)
Kargil


Padum
8kyr
6kyr
5cm=12000m
Durung Drung Glacier
Palaeolake
8kyr (174cm from top)
Kargil

Observations

- Large number of Neolithic occupation in Ladakh at 3000 yrs BP suggest climatic amelioration;
- Preliminary and initial studies in Zanskar suggest very minimal retreat of 1to2m/yr of glacier snout in past about 6kyr;
- Climate was dry between 4 and 1.8 kyr ;
- Between 10 and 4 kyr the monsoon was enhanced in Himachal Pradesh;
- Between 2 and 0.7 myr the climate was arid in NW Himalaya;
- The NW Himalaya witnessed wet and humid climate between 13 and 10 myr.


THANK YOU