



Radiocarbon dating and Glacier Advances since the Last Glaciation Maximum in Tibet and neighboring mountain

Chaolu Yi¹, Lewis A Owen², Kexin Liu³, et al.

1 Institute of Tibetan Plateau Research, CAS

2 Department of Geology, University of Cincinnati

3 Heavy Ion Institute, Peking University

Importance

- | The rapid uplift makes the Tibet plateau become the Quaternary glacial center in middle and low altitudes. Glacial advances indicate the climatic changes, and perhaps suggest the plateau uplift. However, several major problems about Quaternary glaciation in Tibet have still not been solved yet. How many times were the Quaternary glaciations present in Tibet? What is the timing for each glaciation? It is very helpful to clarify these Quaternary glacial problems for understanding past climatic variability in Tibet and surrounding mountains.
- | Many radiocarbon datings were made to determine the ages of the Quaternary glaciations in Tibet and its neighboring mountains in the past two decades. These data are important to understand the timing of past glaciations. We summary these data and present the ages of Quaternary glaciations since the LGM and their similarity and differences in Tibetan area.

Research methods

1 How to gather radiocarbon data?

We got data from literatures, personal communication and the works ourselves

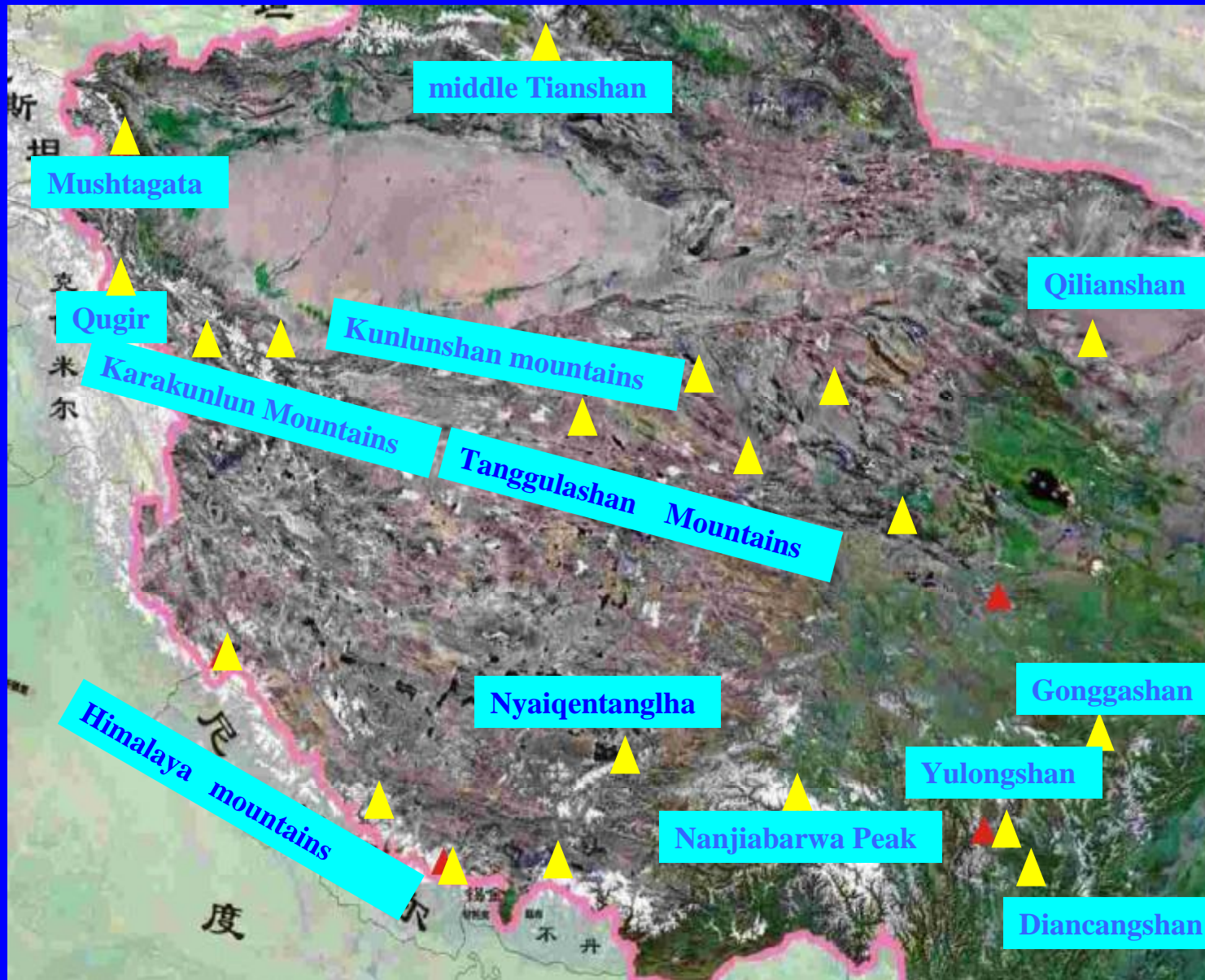
2 Types of ^{14}C dating data

We collect two types of radiocarbon dating from both organic and inorganic matters.

Data collection

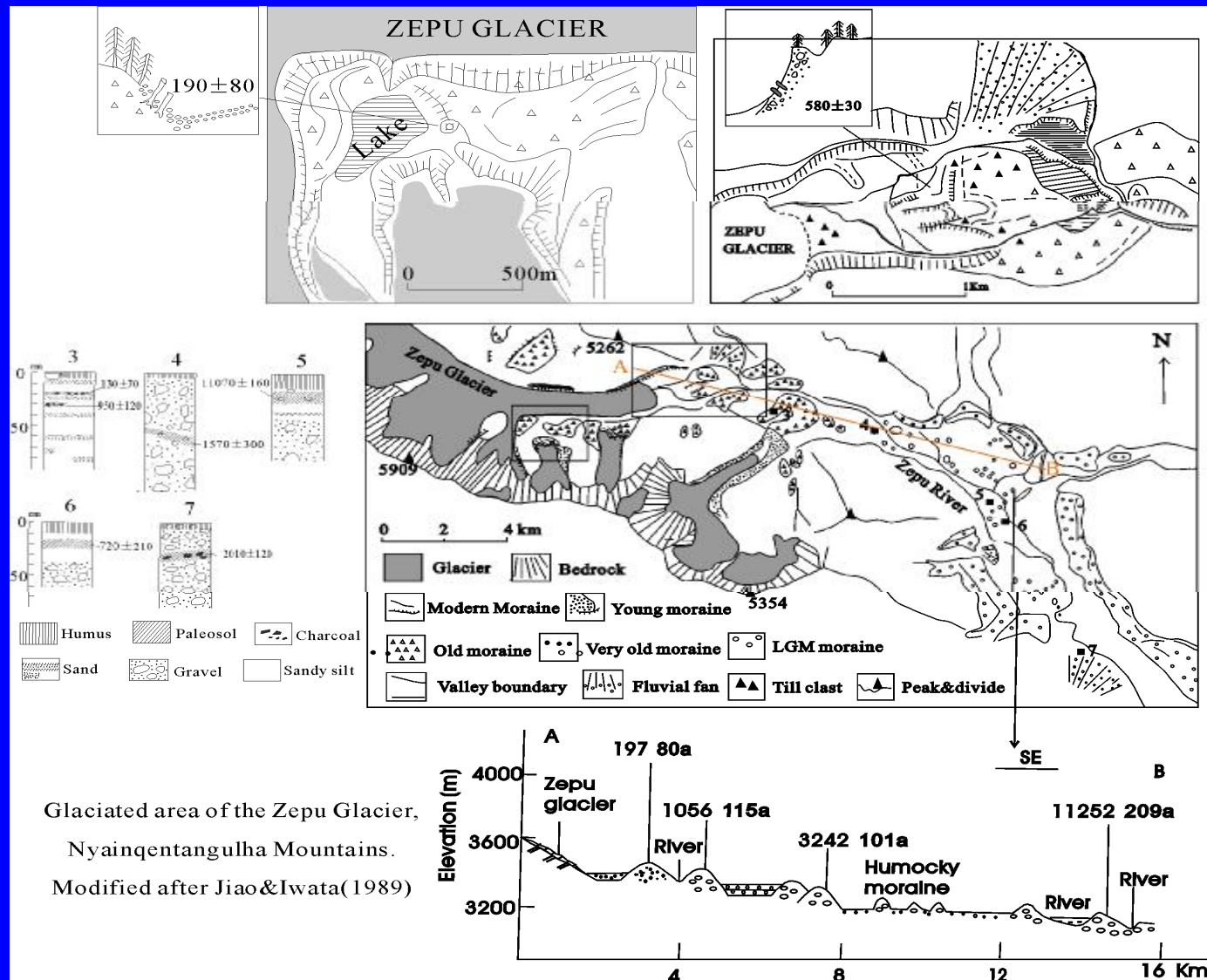
- | 87 radiocarbon dating samples from glacial moraines were collected in Tibet and its neighboring mountains. These sites are in the following mountains.

Study areas where dating data were obtained



How to select data from literature

Example :
Choose
those
which
were
well
describe
and dated



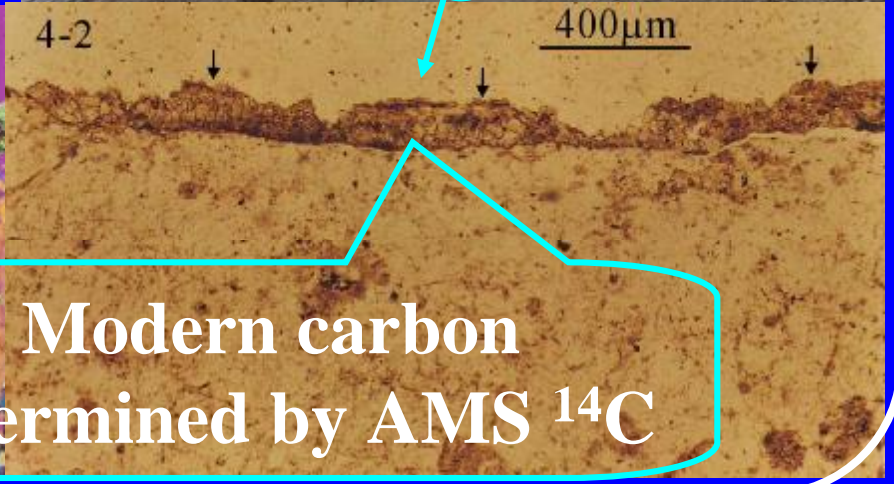
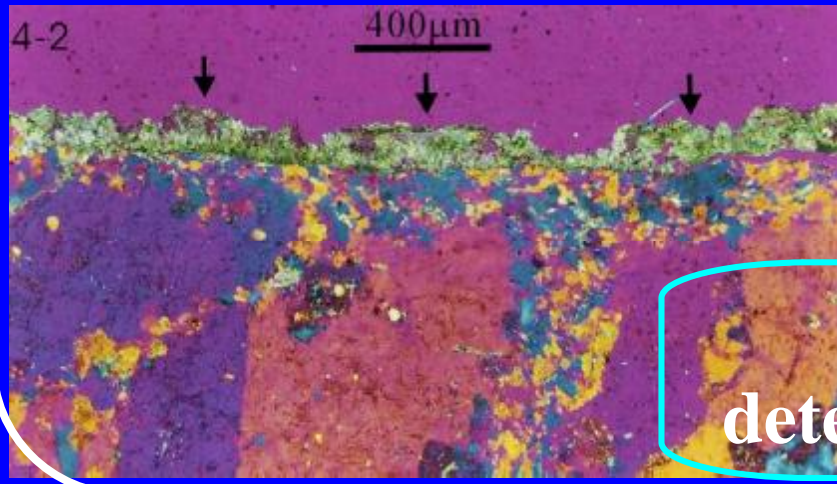
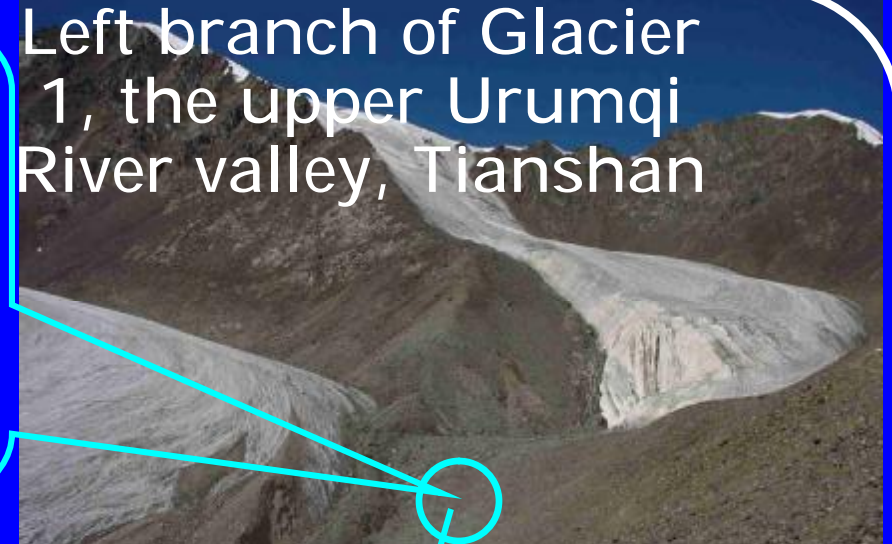
Why choose inorganic radiocarbon dating

- | From the total samples, fifty seven were dated from organic matter, twenty four samples from inorganic matter and three from lichnometric.
- | Why should we choose inorganic radiocarbon dating? Because it is common in glacial sediment in Tibet and it is precise and can be used to determine Quaternary glacial advances in the way we present.

Experimental studies of inorganic ^{14}C dating on glacial till

Modern carbonate precipitates on the interface of ice-rock, and in modern till

Left branch of Glacier 1, the upper Urumqi River valley, Tianshan



Modern carbon determined by AMS ^{14}C

Description of the above slide

- | It is generally believed that organic radiocarbon dating is precise, while inorganic radiocarbon dating has suggested uncertainty to determine the sediment age.
- | However, we found carbonate precipitates in modern till and ice-rock interface at the source area of the Urumqi river valley. They were dated to be modern carbon, suggesting modern carbon is present in modern till.

Experimental studies of inorganic ^{14}C dating on glacial till

- | Carbonate precipitate is also found Nyainqentangulha, Tibet

- | Nyaiqentanglha Shan

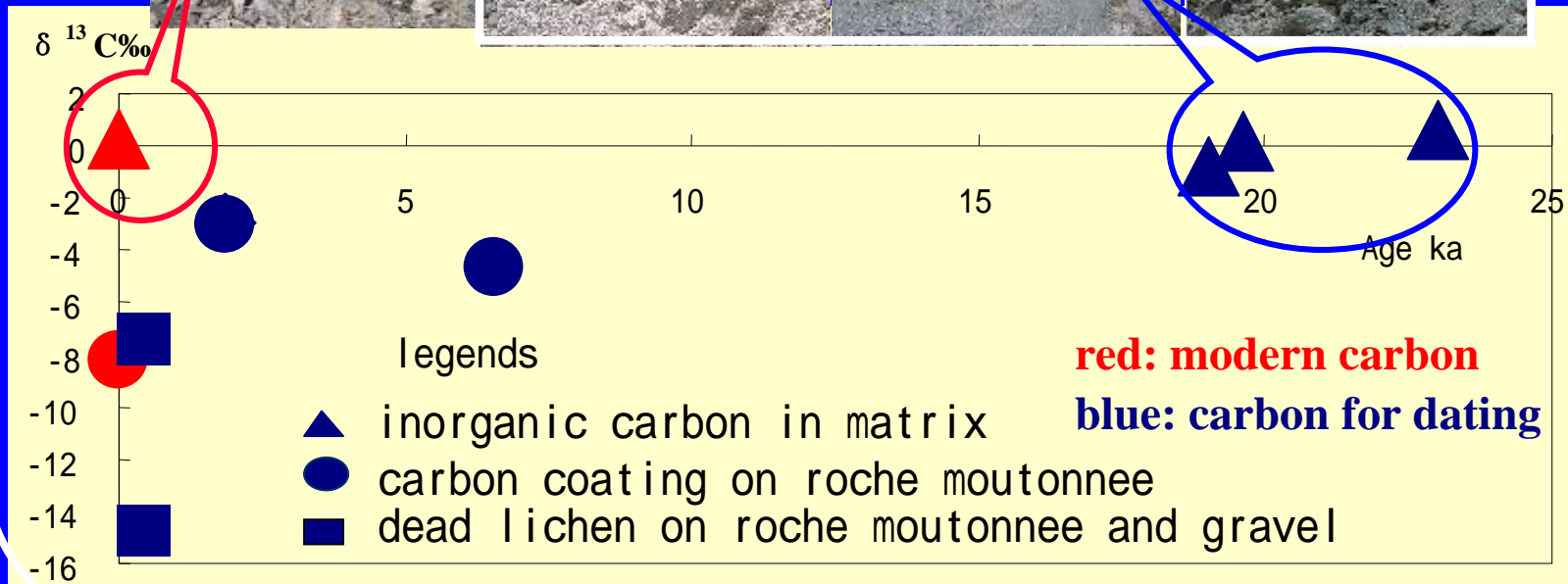


Carbonate precipitates
in modern till



Carbonate precipitates
in modern till

Experimental studies of inorganic ^{14}C dating on glacial



Description of the above slide

- | If the carbon in till changed with the environmental carbon, the values of $\delta^{13}\text{C}$ would change apparently. However, the $\delta^{13}\text{C}$ values in old moraines are similar with those in modern till. It does not suggest the carbon in old moraine has exchanged with the environmental carbon

Inorganic ^{14}C ages change with grain sizes and depth

Grain size	dating	$\delta^{13}\text{C}\text{‰}$
250-125 μm	3890 \pm 30a	-2.23
125-63 μm	3040 \pm 35a	-4.98
\leq 63 μm	4780 \pm 40a	-3.15

Grain size	dating	$\delta^{13}\text{C}\text{‰}$
250-125 μm	10510 \pm 40a	3.53
125-63 μm	10970 \pm 35a	0.54
\leq 63 μm	13820 \pm 45a	3.63

Grain size	dating	$\delta^{13}\text{C}\text{‰}$
250-125 μm	16140 \pm 40a	3.46
125-63 μm	18070 \pm 40a	4.79
\leq 63 μm	19240 \pm 45a	3.68

Organic ^{14}C
of loess cap:
9170 \pm 400a
(Wang, 1981)

The source area of the
Urumqi river valley, Tianshan

Description of the above slide

- | Inorganic ^{14}C ages change with grain sizes and depth
- | We collected three sets of till samples at different depth in the moraine which is believed to be the LGM moraine at the source area of the Urumqi river valley. We sieved each sample into three parts with the grainsize of 0.25-0.125mm, 0.125-0.063mm and smaller than 0.063mm, respectively. We found that the till age is older in small size than in large size, and becomes old from the top to bottom.
- | $\delta^{13}\text{C}$ values are lower in top till than on the modern till, suggesting that the carbon on the top till has exchanged with the environmental carbon.
- | We have proposed that the vertical water movement and void size in till makes the age different (Yi et al, 2004). Our new data further support this idea. Carbon would easily exchange with carbon dioxide through soil expiration on the top surface and thus the age becomes newer. The free water can easily pass through the large voids and the carbonate dissolved in water precipitates on the large particles nearby. It is suggested that new carbon can influence the age of large particles and the matrix in till may preserve the primary calcite as the till was formed.
- | Some comparison study showed (Gu and Li, 1990) that inorganic ^{14}C dating of till was only about 1000 years older than organic ^{14}C dating on till in inner Tibet, supporting the above idea.

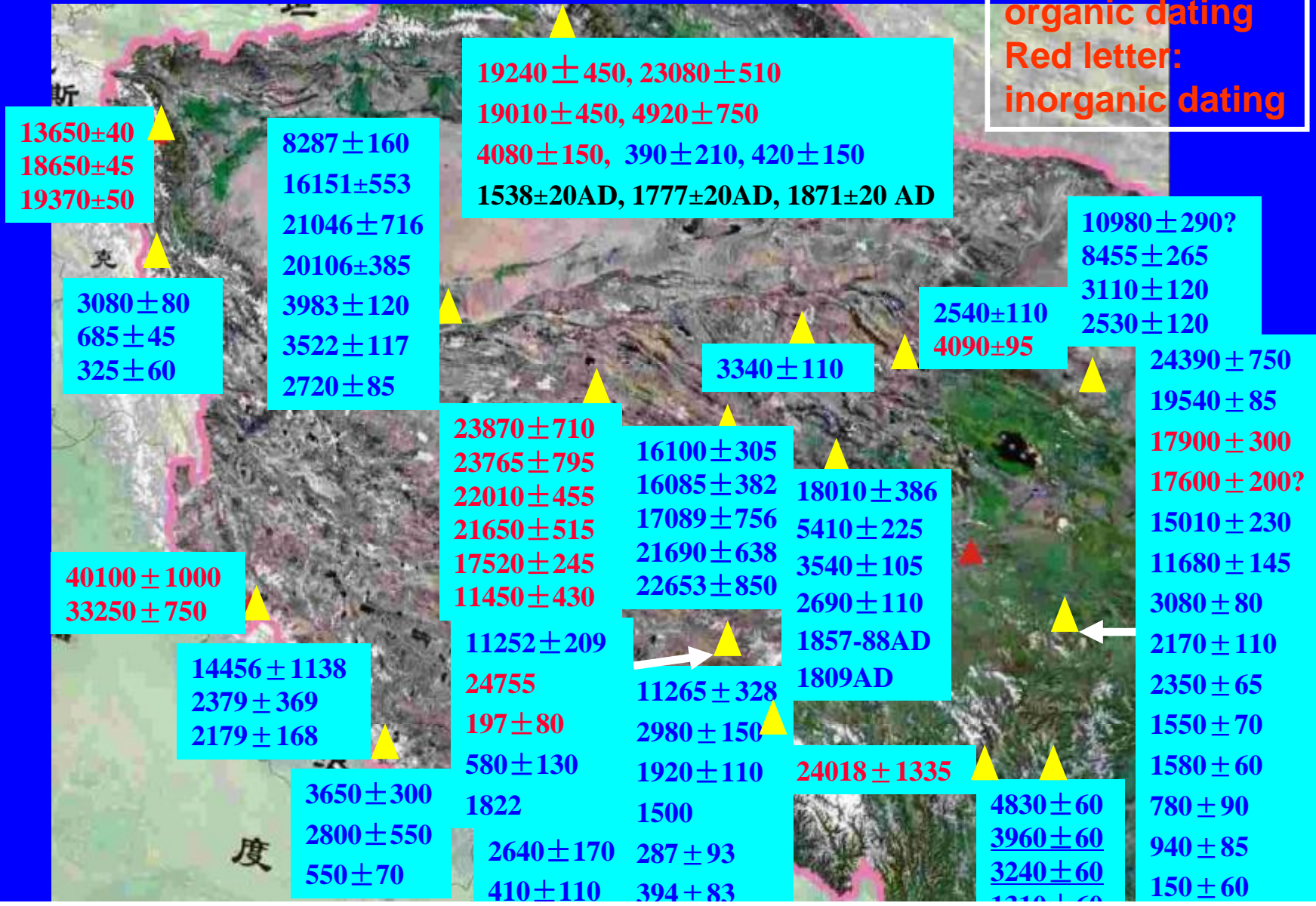
Inorganic carbon dating on glacial till in cold and arid area

We suggest that primary inorganic carbon can be preserved without apparent exchange with the environmental carbon in fine matrix in cold and arid area and can be used for ^{14}C dating

Thus, we also chose those which dated the fine matrix on the bottom of the till exposures as the ages of Quaternary glaciation.

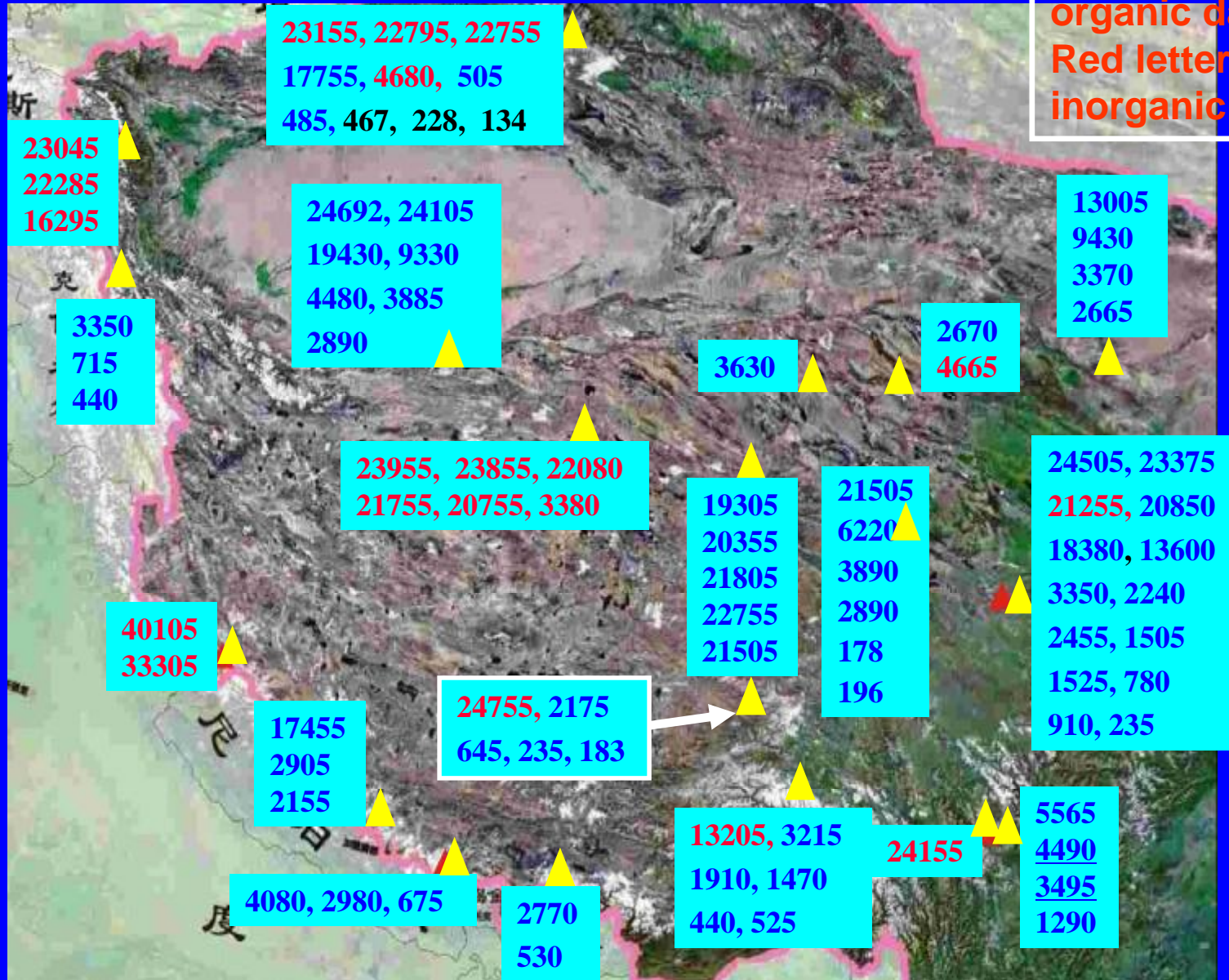
Original 89 ¹⁴C data

Blue letter:
organic dating
Red letter:
inorganic dating

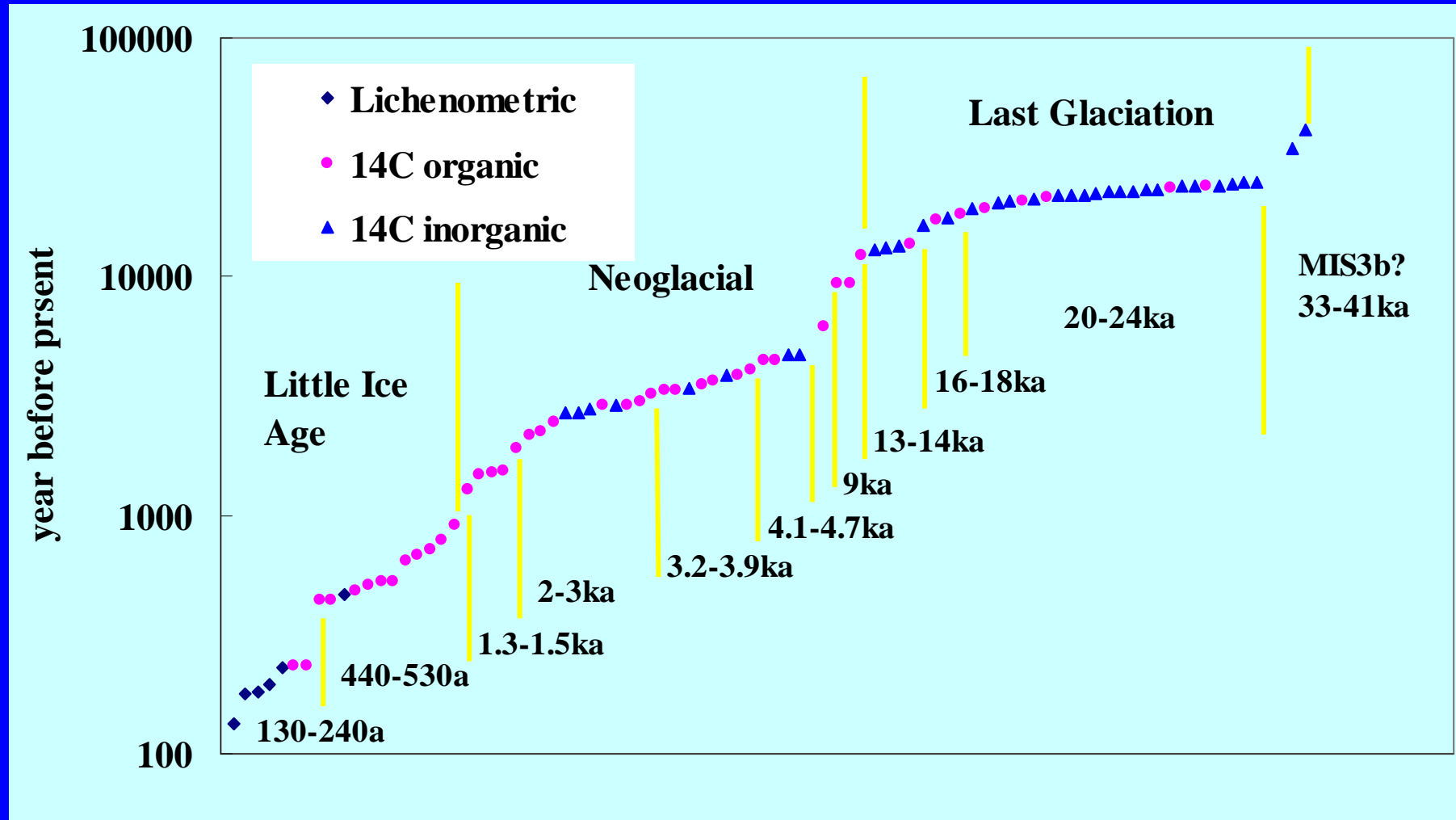


Calibrated ¹⁴C data

Blue letter:
organic dating
Red letter:
inorganic dating



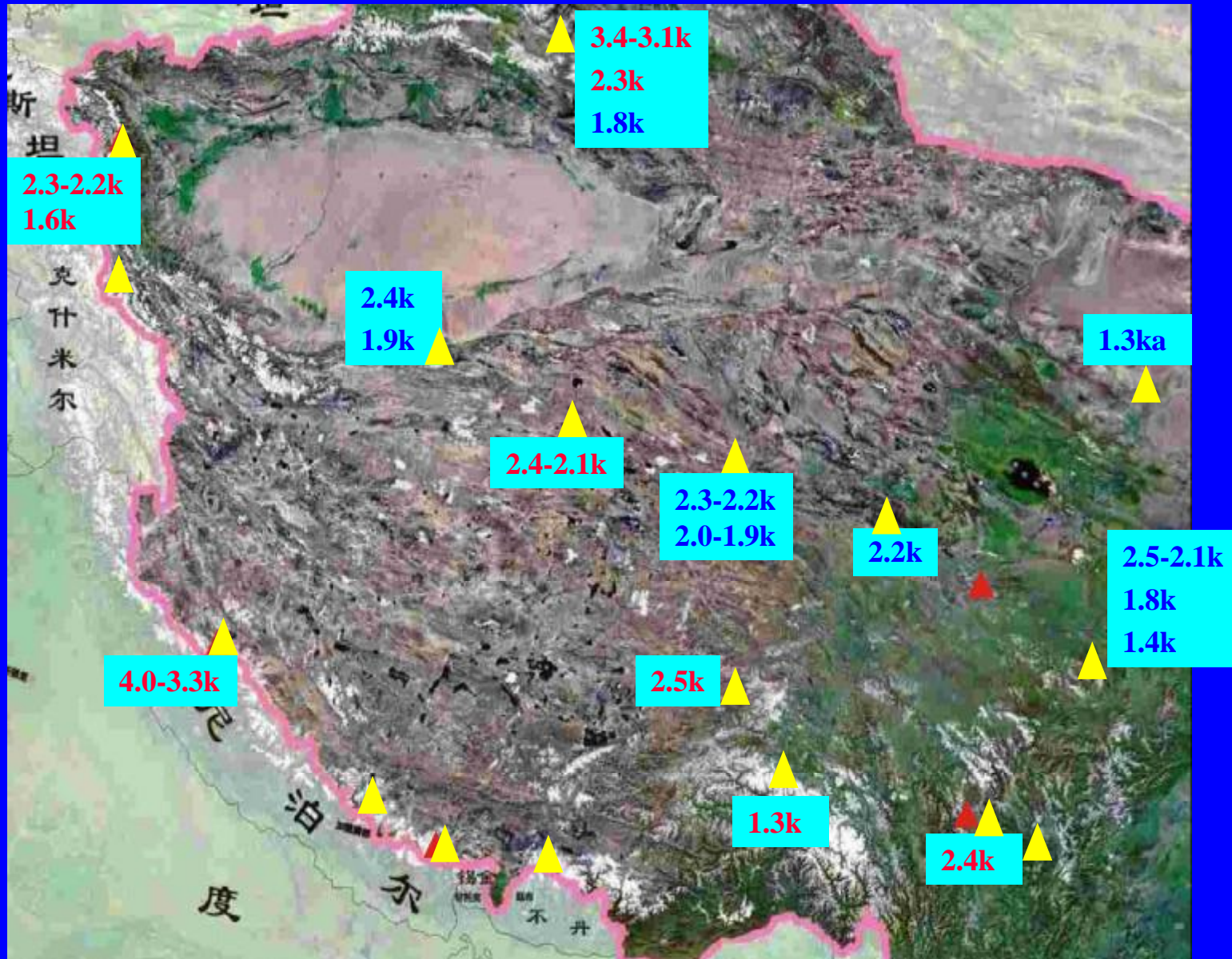
Glacial advances since the LGM



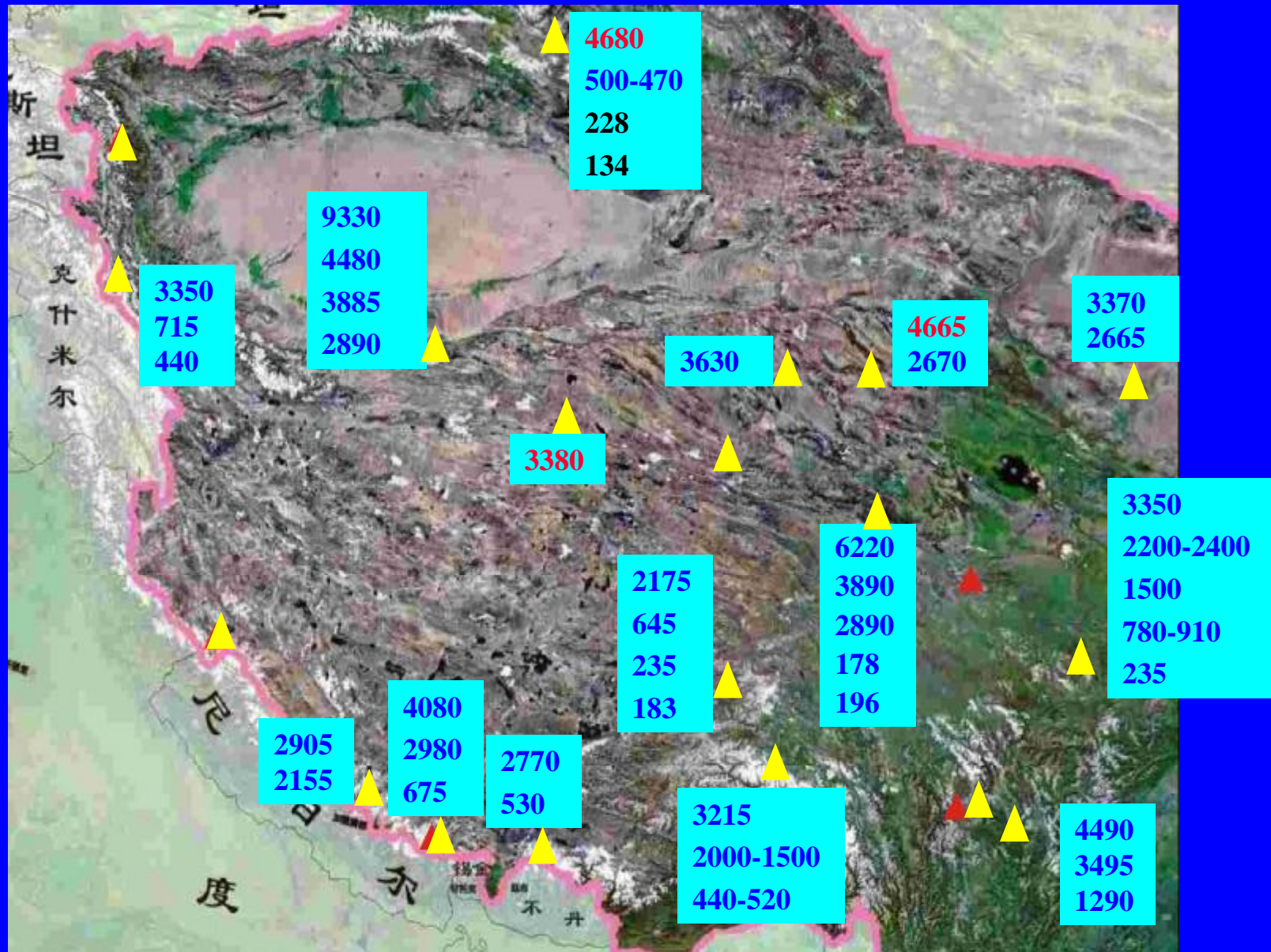
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- The timing of three Pleistocene glacial stages since the LGM is approximately the same in Tibetan Plateau. But the glacial relics were dated on inorganic matter in fine matrix to be 33-41ka in Naimonanyi. It seems to display MIS3b glacial advance in southwest Tibet

Timing of the late Pleistocene glaciations



Timing of Holocene glacial advances



Description of the above slide

- Few data shows presence of glacial advances in early Holocene in west Kunlun Mt, northwestern Tibet. The glacial advances were widespread in 2.9-3.4ka and 4.1-4.7ka in the whole Tibet. There were more glacial advances in southern and eastern Tibetan regions than in western Tibet in Holocene, suggesting the glacial climate was variable in monsoon area

Summary of ^{14}C dating of Quaternary glaciation in Tibet

- | Radiocarbon dating on moraines indicates glacial advances in Tibet and surrounding mountains at
- | Little ice age from 130 aBP to 530 aPB,
- | Neoglacial from 1.3 to 9 kaBP with five substadials of 1.5ka, 2-3ka, 3.2-3.9ka, 4.1-4.7ka and 9ka, and
- | Last Glaciation from 13ka to 41ka with four substadials of 13-14ka, 16-18ka, 20-24ka and 33-41ka.

Summary of ^{14}C dating of Quaternary glaciation in Tibet

- I The temporal variations of glaciations since the LGM in northwest Tibet are synchronous with those in Northern Hemisphere. They were likely linked to Northern Hemisphere cooling events because this region is controlled by Mid-latitude Westerlies. There were more glacial fluctuations in east and south Tibetan regions than northwest Tibet during Holocene, suggesting that the glacial climate was not stable in the south Asian summer monsoon controlled areas.



Thank you