500,000 years of climate history stored year by year

The bottom of Turkey's Lake Van is covered by a layer of mud several hundreds of metres deep. For climatologists this unprepossessing slime is worth its weight in gold: summer by summer pollen has been deposited from times long past. From it they can detect right down to a specific year what climatic conditions prevailed at the time of the Neanderthals, for example.

These archives may go back as much as half a million years. An international team of researchers headed by the University of Bonn now wants to tap this treasure. Preliminary investigations have been a complete success: the researchers were able to prove that the climate has occasionally changed quite suddenly – sometimes within ten or twenty years.

Every summer an inch-thick layer of lime – calcium carbonate – trickles down to find its final resting place at the bottom of Lake Van. Day by day during this period millions and millions of pollen grains float down to the depths. Together with lime they form a light-coloured layer of sediment, what is known as the summer sediment.

In winter the continual 'snowdrift' beneath the surface changes its colour: now clay is the main ingredient in the sediment, which is deposited as a dark brown winter sediment on top of the pollen-lime mix. At a depth of 400 metres no storm or waves disturb this process. These 'annual rings' in the sediment can be traced back for hundreds of thousands of years. 'In some places the layer of sediment is up to 400 metres thick,' the Bonn palaeontologist Professor Thomas Litt explains. 'There are about 20,000 annual strata to every 10 metres,' he calculates. 'We presume that the bottom of Lake Van stores the climate history of the last 800,000 years – an incomparable treasure house of data which we want to tap for at least the last 500,000 years.'

250 metres of sediment = 500,000 years' worth of climate archives

Professor Litt is the spokesman of an international consortium of scientists that wants to get stuck into a thorny problem: using high tech equipment they want to cut drill cores as thick as a man's arm out of the lakebed sediment from a big floating platform – not an easy task at depths of 380 metres. The researchers want to drill down to a sediment depth of 250 metres. For this they have applied for funding by the International Continental Drilling Programme (ICDP). This would be the first time that an ICDP drilling was headed by a German. The prospects of this happening are not bad. A preliminary application was assessed as very good by the ICDP Executive Committee – above all thanks to a successful preliminary investigation which the researchers had carried out at Lake Van in 2004. The German Research Council (Deutsche Forschungsgemeinschaft, DFG) financed this. It has just extended the project for two more years.

The sediment promises to deliver a host of exciting results. For example vulcanologists can determine exactly when volcanoes near the lake erupted. In this case there will suddenly be a black layer of ash between the annual layers. 'With our test drill we counted 15 outbreaks in the past 20,000 years,' Prof. Litt says. 'The composition of the ash even reveals which nearby volcano it originates from.'

Chubby-cheeked pollen

Even earthquakes in this area of high geological activity are painstakingly stored in these archives. What is the most interesting aspect for Thomas Litt, however, is the biological filling contained in the summer layers, especially. The microscopically small pollen tells the palaeobotanist what sorts of things used to

flourish on the shores of the lake. In a piece of sediment the size of a sugar cube up to 200,000 grains of pollen can be trapped. Under the microscope the fine dust reveals a very special kind of beauty. The pollen of yarrow is as prickly as a hedgehog, the pollen of pine with its air sacs resembles the chubby-cheeked face of a hamster, ‘and look at the olive tree,’ Professor Litt enthuses, ‘it’s also got a very nice pollen grain.’

The researcher normally recognises at once what genus or species the finds belong to – even when they are several thousands of years old, since the exine, the outer coat of the grain, successfully resists the ravages of time. ‘The material is extremely resistant to environmental influences and even withstands strong acids or bases,’ Professor Litt explains. Using hydrofluoric acid or potassium hydroxide he dissolves the pollen grains from the sediment samples; the grains prove to be completely impervious to such rough treatment. Under the microscope the botanists then assess how much pollen of which species is present in the layer in question. ‘At interesting points we take every centimetre of material from the drill cores; in this way we achieve a chronological resolution of a few years.’

The pollen permits pretty precise statements to be made about temperature and average amount of precipitation for the period covered by the finds, as every species makes different demands on its environment. ‘If we find pollen in a specimen from different species, whose demands on its habitat are known, we can make a plausibility statement about the nature of the climate of the time,’ he adds. ‘Lake Van promises to provide unique insights into the development of the climate in Eurasia – and thus for assessing the current warm period.’

Source: University of Bonn