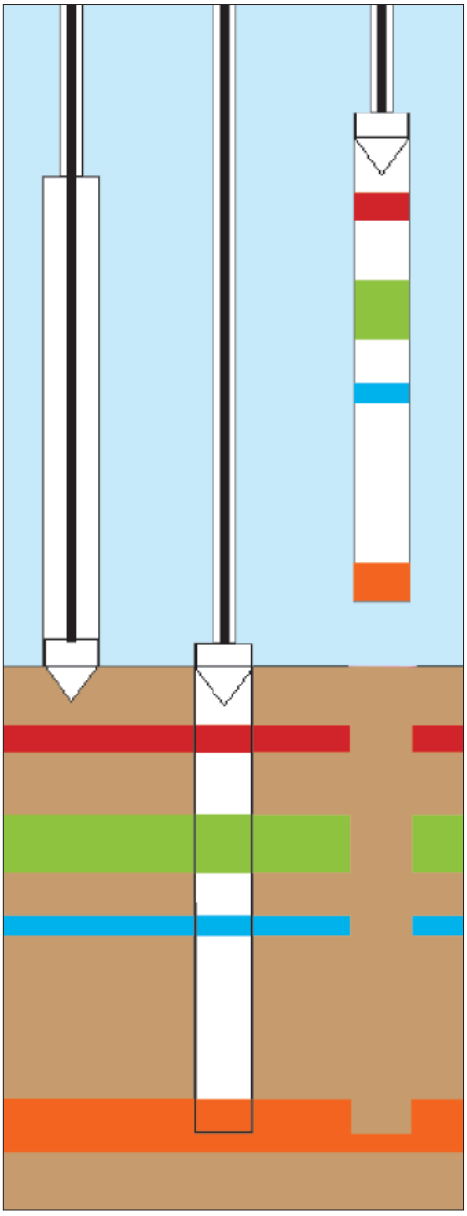

Fig. 1: Principle of piston corer operation in lake sediments

Improvements for Piston Coring Systems: Results of Technical Experiments

The GFZ Potsdam carries out crater lake coring for paleoclimate studies using a system (Fig. 1) based on the "Livingstone Piston Corer" which was modified according to Usinger with an inner rod to hold the piston at a fixed position and a 1 mm thin steel barrel without an inner tube to improve penetration into the sediment (Colman, 1996). Successful coring operations with the recovery of high-quality cores of up to 72 m total composite length at Lago Grande di Monticchio in southern Italy (Allen *et al.*, 1999; Brauer *et al.*, in press), demonstrate the capability of this low-tech hand-operated system. However, preliminary questions have been raised as to the limits and potential upgrading capabilities of this system to increase its capacity.

Systematic experimental investigations on technical or design requirements and parameters for successful continuous core recovery have seldom been published. Most such published data are based on individual experiences derived from field work mainly based on specific sediment types and pertaining to certain applications. These cannot be readily generalised and transferred to other technical systems or sediments.

This lack of basic technical background information in a currently rapidly developing research field inspired us to initiate a co-operation between drilling engineers and geoscientists to accumulate data on potential improvements of lake sediment coring devices.

We performed coring experiments in a 30 m deep testing shaft of the Institute of Oil and Gas Technology at the Technical University of Clausthal with the financial support of the Deutsche Forschungsgemeinschaft (DFG). These tests were performed on two geotechnically different end-member types of sediments: a medium-grained very homogeneous sand and a clay-rich fine-grained silt. For each experiment both sediment types were homogeneously and complexly packed into 3 m long steel test pipes (inner diameter: 30 cm) and then mounted into the testing shaft. The experiments included several variations in parameters such as core barrel coating, energy input and frequency. These were evaluated for core penetration as well as total core rod length and the length of individual rods.

The most noteworthy results of these tests are presented in the two diagrams of Fig. 2. The results demonstrate that the surface of the barrel is extremely important for the penetration rate especially in sand-rich sediments. An easy and rather inexpensive method is to carbo-nitrate coat and oxidize the barrels, with the result of doubling the penetration rate in comparison to an unmodified steel barrel surface.

Core barrel type	***Energy***	***Pipe Length***	***Sediment***
original	*hammer weight*	*2 m*	*sand*
with cutting shoe	*high-frequency vibrator*	*17 m*	*clayey silt*
chromium-plated	*Wacker-hammer*	*25 m*	
partly chromium-plated	*Cobra-hammer*		
nickel-plated	*Hydraulic-hammer*		
nitrated and oxidized			

Tab. 1: Test program and parameters investigated

Other important results of the study are:

- Frequency and impact force of common hand-held and motor-driven hammers such as the Wacker Hammer, yield high penetration rates. A high-frequency impact force did not result in increased total penetration or higher penetration per impact.
- The highest penetration per stroke is always achieved during the first beats. Pausing between impacts or stand-by time prior to retraction causes strong enhancement of sediment adhesion.
- Not the total length of the pipe but the number and type of connectors is critical for the energy yield at the tip of the piston. Each connector (tool joint) may cause a few percent dampening of each stroke. Therefore, connections must be very tightly closed and connector types with a high stroke energy throughput should be prioritised. Long pipes and/or a low number of connectors are of paramount importance for the transfer of energy downhole.

The GFZ piston corer has already been redesigned taking into account some of the results of this study. After modification it was applied on Lago Grande di Monticchio in late Summer 2000 with great success. In 12 m water depth 94 m of continuous high-quality core have been recovered with an overall operated system length of 110 m. In comparison to the previous operation on the same lake a depth increment of more than 30% was achieved.

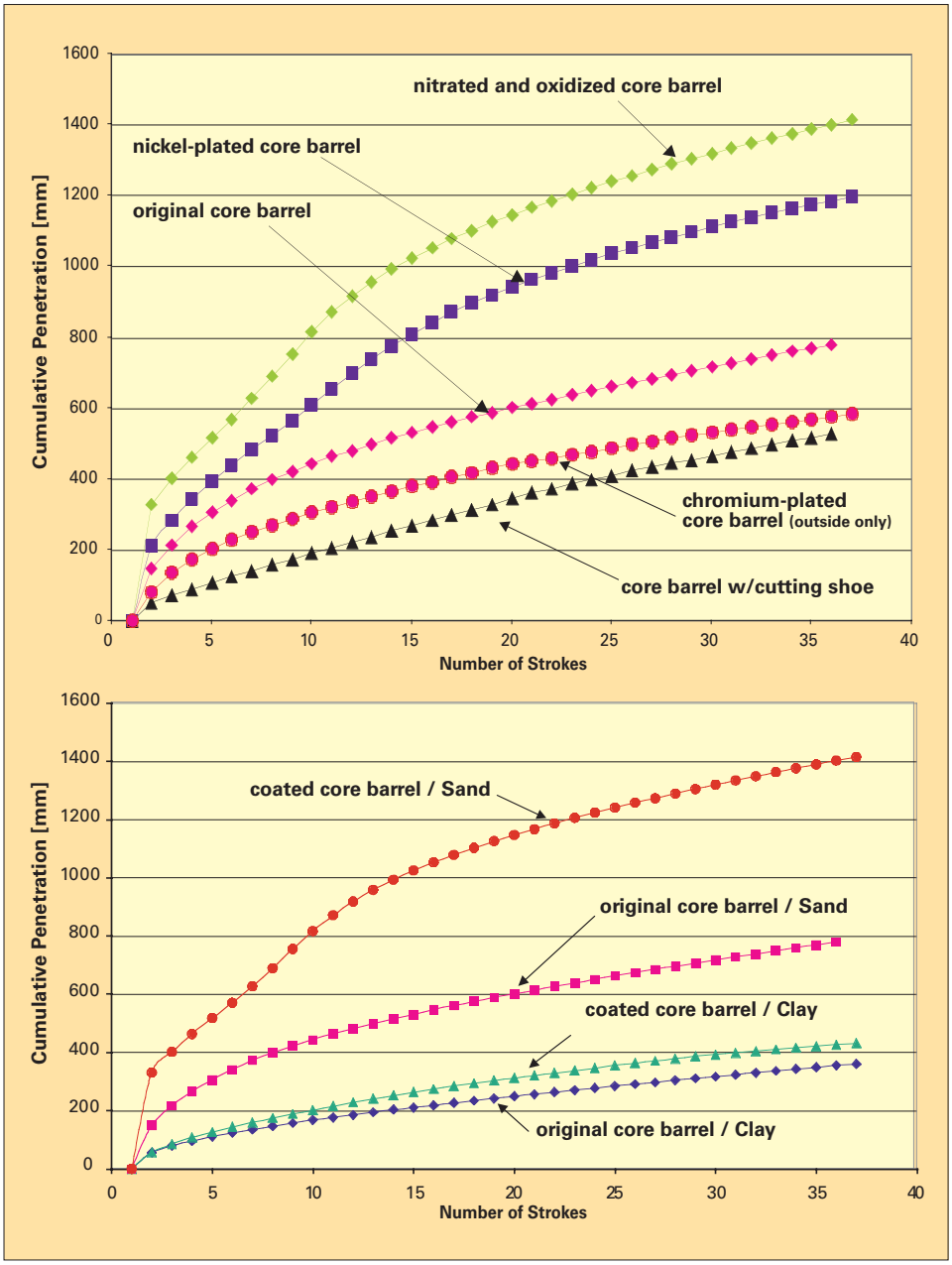

Fig. 2: Cumulative penetration rate against number of strokes with different barrel coatings in sand (top) and a comparison of piston coatings with highest and lowest penetration rates in sand and in clayey silt (bottom).

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For full references please consult *www.pages-igbp.org/products/newsletters/ref2003.html*

PAGES Website News

The PAGES website is now accessible using the url ***http://www.pages-igbp.org***, although the old url (*http://www.pages.unibe.ch*) will continue to work as well. Email addresses at the PAGES IPO remain unchanged. The new web URL has been chosen in order to provide a clear indication of our connection with IGBP, PAGES' parent body, and to indicate that pages is an independent non-profit organization, rather than a subsidiary of the University of Bern.