No change in the height of the Matterhorn

The Matterhorn is precisely 4477.54 metres high – and remains at 4478 metres according to the maps. In the September 1999 re-survey featured in a recent "Reporter", Italian geology professor Giorgio Poretti was the first to position a GPS surveying system on the peak, with LEICA GPS500s at reference points in the valleys on either side. All points were additionally measured using optical laser triangulation.

The Matterhorn is the world's third mountain, after Mt. Everest and Kilimanjaro, to be re-surveyed using the latest technology based on GPS, the Global Positioning System. The height of the Matterhorn is now known with centimetre accuracy,

Left: The measurement setup at the peak of the Matterhorn: LEICA GPS500 and reflectors for the tacheometers in the valleys on either side.

One of the points used in the survey was the cross at the peak of the Matterhorn, shown here with an SR500 lashed to it.

allowing height and position changes of this prominent Swiss-Italian landmark to be precisely tracked. It is apparent that this part of the Alps will continue rising faster than the annual rate of erosion.

27 centimetres between countries

According to Urs Marti of the Swiss Federal Survey, the height of the Matterhorn was originally determined in the 1920s. Back then, Zermatt's local landmark was measured at 4477.50 metres and declared on official Swiss maps as being 4478 metres above sea level. Yet as Zermatt-based geometrician Klaus Aufdenblatten points out, "the measurement uncertainty of the cumbersome opto-mechanical triangulation methods then in use was several decimetres at these distances". In addition to greater precision, such cross-border surveying projects have also provided evidence of discrepancies between national geoids, which could be reconciled over the medium term. Poretti detected a "border step" of 27 centimetres between Italian and Swiss geoid data.

Ancient African rock

Confirmation of the 4478 metre height means that the Matterhorn, formed of rock originating from what is now Africa, has been spared the numerical indignity recently suffered by Kilimanjaro (see Reporter 44).

The highest mountains on the six continents

Continent	Highest mountain	Height above sea level
Asia	Mt. Everest	8846 metres *
America:	Aconcagua	6959 metres **
Africa:	Kilimanjaro	5892 metres *
Antarctica:	Mt. Vinson	5140 metres **
Europe:	Mont Blanc	4808 metres **
Australia:	Mt. Kosciusko	2230 metres **

* Surveyed using LEICA GPS 300/500 during the last decade;
** Surveyed using Leica Geosystems theodolites during the last century

In October 1999, an expedition led by Eberhard Messmer also used LEICA GPS500 systems to determine a new height of 5892 metres, superseding the earlier figure of 5895 metres. And eight years ago, Giorgio Poretti and Yun-Jong Chen used a similar measurement configuration – with instruments on the peak and in the Nepalese and Tibetan valleys – to redefine the height of Mt. Everest at 8846.10 metres above sea level. Problems with metre-high layers of snow and ice covering the peak of Everest were not an issue on the Matterhorn.

Measurements from the valley on the Swiss side (Zermatt) were taken simultaneously with a LEICA GPS500 and TCA2003.

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Taking up position at the peak of the Matterhorn.

The Swiss Federal Survey map was used to pinpoint the precisely defined station point in Zermatt for the Matterhorn re-survey.

Drifting continental plates caused ancient African rock to tower up into what is now the Matterhorn.

A century of surveying history

Experts with an eye for surveying history saw the Matterhorn measurement as symbolic of a technological revolution. It was here in canton Valais, within sight of the Matterhorn, that Heinrich Wild, topographer and later instrument designer, used an enormous, mechanical repetition theodolite on the Dents-du-Midi to chart the lower Valais in 1902. Struck by the laboriousness of this method, he went on to develop lighter, opto-mechanical instruments like the Wild T2 is the forerunner of the modern electronic tacheometer – give or take little extras like laser technology, electronic angle measurement and sophisticated software.

Giorgio Poretti took a WILD T2 along with a LEICA GPS500 to the peak of the Matterhorn and used it to sight down to the valley, where further GPS500 systems were complemented by LEICA T2002, LEICA DI3000 and LEICA TCA2003 electronic theodolites and infrared distance measurement equipment. Giorgio Poretti was also interested in comparative measurements as a means of determining whether, and by how much, rays in various parts of the electromagnetic spectrum (GPS microwaves, DI3000 infrared laser light, T2 visible light) were affected by the atmosphere at great differences in altitude as they travelled to and from a prominent and isolated mountain like the Matterhorn, and whether these effects could be used to indicate meteorological changes.

A LEICA GPS500 in the valley on the Italian side. The "Cervino", as the Matterhorn is known in Italian, looks completely different from this viewpoint.