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Geomagnetic observations at a lightning stroke place

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Below the surface of the Earth lightning strokes have only small effects. One of them is the remanent magnetization of rocks by the circular magnetic field that accompanies the current of the lightning. This remanent magnetization can persist over many years although the magnetic field of the lightning lasts only a fraction of a second.

Rocks magnetized by lightning are often found at conspicuous points like mountain peaks, much more seldom however in flat terrain. The lightning stroke place described here was found during a geomagnetic survey on the gently rising flank of the fairly modest remainder of a Tertiary volcano near Göttingen. The detailed investigations started with two surveys of the magnetic field in the vicinity of the stroke place. Afterwards rock samples were taken down to a depth of nearly 3 m. They show the circular remanent magnetization that can be expected due to the magnetic field of the lightning. The magnetization decreases with increasing distance from the presumed lightning axis, at 5 m distance it is only a tenth of the central values. The magnetic field that could produce the observed magnetization distribution corresponds to a lightning current of 250 000 A.

The observed magnetizations were used to calculate the magnetic field over the lightning stroke place. The first result of the model calculations appears surprising: The remanent magnetization that is produced by a vertical lightning in a horizontally layered medium does not generate a magnetic anomaly above the surface. This resembles a toroidal coil that also does not produce a magnetic field outside of the coil. In the case investigated here the angle between the lightning current and the plumb line was 15°. Thus some of the rings of magnetization are open at the surface, and they produce magnetic fields that are similar to those of horseshoe magnets. The calculated magnetic anomaly pattern fits very well to the observations.

Between the two surveys and before the sampling a lightning stroke occurred at ex-

actly the same place. It increased the anomaly by 10 % without changing its shape. No reason was found why two independent lightning strokes occurred at this inconspicuous place. None of the high beech trees in the neighbourhood shows any damage by lightning.

I suspected that the extraordinary high calculated lightning current 250 000 A might not correspond to one lightning. Therefore I applied repeatedly short dc magnetizations to some samples, thus simulating repeated lightning strokes. Indeed they increase the remanent magnetization if a considerable time span - several weeks are sufficient - lies between the magnetizations. Thus, the calculated current 250 000 A is not the current of one lightning. Instead it is caused by the overall effects of possibly numerous lightnings that occurred during many years at exactly the same place.