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Magnetometers for Geoscience (Christiaan Huygens Medal Lecture)

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Measuring the Earth's magnetic field is one of the first metrological actions of humankind, traceable till about 5000 years BC. It is remarkable that the interest in magnetic fields measurements still is growing and the scope of their applications is getting wider and wider. The progress in the recent 20-30 years in the development of magnetometers of different kinds is highly impressive. Currently practically all scales of the magnetic field values can be measured – from the huge magnetic fields of astronomical objects down to atto-Tesla levels.

A modern flux-gate magnetometer (FGM) may cover an amazing dynamic range of the magnetic field, ranging from 10-4 down to 10-12 T, and even lower. The second most important parameter, the zero line drift, may reach below 10-5 of the full measurement scale per year. Development of state of the art FGMs requires profound research activity in various science disciplines: mathematics, metrology, electronics and material science to name a few.

This talk reviews the principles of various types of existing magnetometers and their main performance aspects are compared. It is shown that the most suitable type of instrument for measurements of the magnetic fields in the range applicable for geosciences is the FGM. A few highlights of recent developments of FGMs, with record parameters concerning noise level and power consumption, are given. Techniques to lower the noise to a cutting edge level are described and a new physical phenomenon discovered during this development work is reported and explained. Advancement in flux-gate magnetometry is discussed and a few specific examples are presented: a) a one-second INTERMAGNET-compatible FGM, b) a super-low power FGM, c) the lowest available noise FGM and d) the smallest but sensitive FGM for nano-satellites.

Finally some applications for FGM use in geosciences are given and envisaged progress in the future development in the field of magnetic observations is discussed.