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From Petrus Peregrinus to the the supercomputer: the story of the geodynamo

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Our understanding of the processes by which the Earth generates its magnetic field by means of dynamo action in the core has developed significantly over the last fifteen years. During that time, it has become possible to solve the fundamental equations governing the fluid flow in the Earth's core, the Navier-Stokes equations and Maxwell's equations, with the aid of powerful computers. These numerical simulations of the geodynamo are based on information from many different branches of geophysics. Seismology has given us the dimensions and structure of the core, high pressure physics has told us the physical properties of the fluid we are dealing with, while geomagnetism and paleomagnetism indicate the nature of the fields that have to be generated. Even the variations of the rotation rate and the heat flux emerging from the surface are relevant to the core dynamics and hence to the geodynamo. The models can give plausible field strengths, a field morphology generally compatible with the known geomagnetic field, and can even reproduce field reversal events.They are also compatible with what is known about core dynamics.

This new understanding is however based on the advances in our knowledge of the nature of geomagnetism over many hundreds of years. These major contributions will be reviewed, and how they have led to our present picture of core dynamics and field generation will be discussed. Finally, we will look to the future, at the many unsolved challenges we face, and how the knowledge gained from the Earth's dynamo might be extended to better understand the fields on other planets.