

IUGS International Commission on the History of Geological Sciences (INHIGEO)

IUGS INHIGEO Anniversaries: April 1719:

Mairan places the question of the Earth's 'central fire' on a new footing

By Kenneth L. Taylor, Professor emeritus of the History of Science, University of Oklahoma, USA. Past President of INHIGEO (2012–16). (ktaylor@ou.edu)

[Short summary]

300 years ago, J.-J. Dortous de Mairan stirred up renewed debate over the possibility that the Earth contains an internal heat reservoir, in a paper presented to the Paris Academy of Sciences. That the Earth has within it a 'central fire' was an idea embodied in conjectural theories that had been put forward by a number of physical theorists, notably Descartes and Leibniz. Mairan's approach to the problem was through a climatological question: do measured differences in winter cold and summer heat at a given latitude conform with the supposition that the Sun is Earth's only source of heat? Through an elaborate series of calculations Mairan argued that the Earth must have some additional, intrinsic heat resource. His arguments were exploited by 18th-century advocates of Earth's *feu central*, but they remained controversial throughout the century.

[Expanded version:]

In Paris on 19 April 1719, the French natural philosopher Jean-Jacques Dortous de Mairan (1678–1771) presented to the Académie Royale des Sciences the results of his study of “the general cause of cold in winter and of heat in summer.” Although the heart of the issue in this paper concerned a climatological question, one of its main consequences was to enliven and transform an already existing debate over the existence of a great reservoir of heat within the Earth. A number of prominent physical theorists of the 17th century, among them René Descartes and Gottfried Wilhelm von Leibniz, had advocated the Earth's igneous origins, suggesting that subsequent cooling accounted for certain discernible terrestrial features. But these speculative accounts, which were by no means universally accepted, had as yet received little critical empirical examination.

Now Mairan sought to determine whether the seasonal differences in temperature at a given location on Earth were compatible with the proposition that the planet's sole source of surface warmth lay in receipt of Solar radiation. His analysis, which might be viewed as a forerunner of a modern 'climatological heat budget,' appeared to indicate that it was not. The

main basis of this conclusion drew from Mairan's supposition that at a given latitude (such as that of Paris) the different quantities of received Solar heat in summer and winter could be gauged through two sorts of measurement, each one calibrated through the changing seasons: the angle of incidence (obliquity) of Solar rays, and the duration of incident daylight. His calculations showed, he said, that the differing quantities of Solar heat received during summer and winter ought to yield far greater discrepancies in measured seasonal temperatures than are in fact observed. So he judged that heat from within the Earth must account for the comparatively modest seasonal differences in temperature.

Mairan elaborated on these results in 1721, and again at length in 1765. His conclusions were used by authors such as the Comte de Buffon and J.-S. Bailly in their defenses of the theory of internal terrestrial heat. This contention remained controversial, however, throughout the 18th century; one conspicuous opponent was J.-B. Romé de l'Isle. With the development of a mathematized thermodynamics in the 19th century, a consensus then began to take shape in favor of the existence of a heat source intrinsic to the Earth. It may be argued, however, that Mairan was the first to attempt an extensive quantitative examination of the problem — an approach which proved fundamental to eventual resolution of the issue.

Further reading:

Brush, Stephen G. 1996. *A History of Modern Planetary Physics*. Vol. 1: *Nebulous Earth: The origin of the Solar System and the core of the Earth from Laplace to Jeffreys*. Cambridge University Press. (Esp. chap. 5.)

Hine, Ellen McNiven, 2008. Mairan, Jean-Jacques Dortous de. *New Dictionary of Scientific Biography*, Vol. 5, pp. 10–13.

Kleinbaum, Abby Rose. 1970. *Jean Jacques Dortous de Mairan (1678–1771): A study of an Enlightenment scientist*. PhD dissertation, Columbia University.

Mairan, Jean-Jacques Dortous de. 1719. Mémoire sur la cause générale du froid en hiver, & de la chaleur en été. *Mémoires de l'Académie royale des Sciences*, Paris, 1719 [published 1721], pp. 104–135.

Mairan, Jean-Jacques Dortous de. 1721. Éclaircissement sur le mémoire de la cause générale du froid en hiver, & de la chaleur en été. *Mémoires de l'Académie royale des Sciences*, Paris, 1721 [published 1723], pp. 8–17.

Mairan, Jean-Jacques Dortous de. 1765. Nouvelles recherches sur la cause générale du chaud en été & du froid en hiver, en tant qu'elle se lie à la chaleur interne & permanente de la Terre; en supplément & correction au mémoire qui fut donné sur ce sujet dans le volume de 1719, page 104. *Mémoires de l'Académie royale des Sciences*, Paris, 1765 [published 1768], pp. 143–266.



Figure 1: Portrait of J.-J. Dortous de Mairan. From a painting by Louis Tocqué, engraving by Étienne Ficquet. Author's collection.