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Late Permian paleomagnetic results from the Lodève, Le Luc, and Bas-Argens Basins (southern France): Magnetostratigraphy and geomagnetic field morphology

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ABSTRACT

Paleomagnetic results are presented from 271 stratigraphically-ordered horizons at four locations in southern France. Our focus is mainly on the Late Permian (258 horizons), but results from 13 horizons in the Triassic Buntsandstein are also reported. We argue that the Permian results extend magnetostratigraphic coverage up to the upper Capitanian Stage, some 6 million years after the end of the Permo-Carboniferous Reversed Superchron defined by the Illawarra Reversal in the Wordian Stage. When combined with published data, an overall mean paleopole at 49°N, 161°E (A_{95} = 4°, N = 9) is obtained. This is virtually identical to the upper Permian pole obtained by Bazhenov and Shatsillo (2010) using the intersecting great-circle method. Agreement between the two procedures, which are based on entirely independent data, supports the geocentric axial dipole (GAD) model.

1. Introduction

Two characteristics of the geomagnetic field are of particular interest to paleomagnetists: polarity and morphology. In the present case, these are approached using new results from southern France obtained as the first step in a project to investigate as many suitable targets as possible along a paleomeridional belt covering the full extent of the Permian Eurasian Plate—from Iberia to Siberia. Most of the strata investigated were deposited in the Late Permian and span the end of the Permo-Carboniferous Reversed Superchron (PCRS). Several published results from southern France come from lower stratigraphic horizons, so that much of the PCRS is now reasonably-well covered. Having a duration of some 50 million years, the PCRS is the longest interval of constant polarity discovered so far—from ~318 to ~267 Ma, according to the latest global summary (Gradstein et al., 2012). Such a feature is of great interest to the history of the geodynamo, and thus to the geodynamics and thermal evolution of Earth's interior. Paleomagnetic results from this time interval have also played an important role in the long-debated reconstruction of Pangea and the associated problem of the morphology of the geomagnetic field. We therefore scrutinize our new results, in conjunction with the published record, to assess the validity of the geocentric axial dipole (GAD) model in the geological past.

2. Sampling and laboratory measurements

Oriented samples were collected at four localities in southern France: one in the Lodève Basin (~40 km WNW of Montpellier), and three in the Le Luc and Bas-Argens Basins (~40 and ~70 km NE of Toulon, respectively) (Fig. 1). Orientation was by magnetic compass and bubble inclinometer. A total of 416 samples were collected over a combined stratigraphic thickness of 281 m (Table 1A). A single sample was collected at each horizon in order to maximize the density of stratigraphic coverage and thus reduce the chance of missing short polarity events. The entire collection involved seven stratigraphically-ordered sequences, but most of our samples come from the two long sections at La Lieude (La Lieude Formation) and Gonfaron 1 (Pélitique Formation) (Table 1B summarizes the relevant stratigraphic nomenclature). The remaining five sequences were exploratory in nature as we attempted to probe higher stratigraphic levels where outcrops are more restricted. Gonfaron 2b also belongs to the Pélitique Formation, Le Muy 2 samples the La

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