The Permo-Carboniferous Saar-Nahe Basin, south-west Germany and north-east France: basin formation and deformation in a strike-slip regime

Abstract The Permo-Carboniferous Saar-Nahe Basin in south-west Germany and north-east France formed at the boundary between the Rhenohercynian and Saxothuringian zones within the Variscan orogen, where non-marine sediments were deposited in a narrow, structurally controlled basin. The basin has an asymmetrical geometry perpendicular to the South Hunsrück Fault. However, there is a lack of growth of the sediment pile into the fault, and isopach maps show the depocentre always located adjacent to the South Hunsrück Fault, but migrating towards the north-east with time. This pattern is typical of a strike-slip basin, indicating that the South Hunsrück Fault was a dextral strike-slip fault during sedimentation. Tectonic subsidence curves indicate that, during the Middle Devonian to Early Carboniferous, the basin subsided due to thermal relaxation of the lithosphere. A change to very rapid subsidence at the start of the Westphalian continued until late in the Autunian. This was due to mechanical subsidence associated with strike-slip movement on the South Hunsrück Fault. Towards the end of subsidence in the Saar-Nahe Basin, the Grenzlager volcanics introduced a thermal pulse into the crust, leading to thermal cooling and relaxation of the lithosphere.

Key words Saar-Nahe Basin · Strike-slip basin · Tectonic subsidence curves · Variscan tectonics · Cross-sections · Isopachs

Introduction

There are at least two discrete tectonic settings for sedimentary basins that formed simultaneously during the Late Palaeozoic Variscan orogeny in western Europe (Fig. 1) (e.g. Read and Watson 1975; Ziegler 1982). Immediately adjacent to, and to the north of, the Variscan deformation fronts, narrow foredeep basins formed where rapid subsidence led to the accumulation of thick non-marine sediments with marine intercalations. These are the external basins, of which the Ruhr Basin is an example. They are interpreted to have formed as shortening (foreland) basins, with subsidence being controlled by thrust-loading of the crust during Variscan shortening in the Rhenohercynian zone to the south (e.g. Ziegler 1984; Drozdzewski 1992).

More enigmatic are the internal basins – that is, those basins that formed within the Variscan orogenic belt to the south, where wholly non-marine Late Carboniferous to Early Permian sediments were deposited in structurally controlled basins. The Saar-Nahe Basin (Fig. 2), which is the focus of this paper, is one of the largest and best exposed examples of these basins.

This paper develops a tectonic model for the evolution of the Saar-Nahe Basin by examining its geometry, the relationship of the basin geometry to the sediment fill, the mechanisms of formation of the basin and the tectonic relationships between the basin and the surrounding basement.

The Saar-Nahe Basin

The Saar-Nahe Basin is a Late Variscan (?latest Namurian or Westphalian to Saxonian) intramontane basin dominated by clastic continental sediments of alluvial fans, braided and meandering rivers, deltaic and lacustrine facies (Schäfer 1986, 1989). Palaeocurrent data (Schäfer 1980, 1986) indicate that during the Westphalian the sediment transport was from the Rheinisches...
Schiefergebirge (Rhenohercynian zone); thick coal measures also developed at this time. From the Stephanian to the Saxonian, sediment transport was from the southern Moldanubian zone.

Lithostratigraphy and biostratigraphy

The lithostratigraphic subdivisions used here and our allocation of numerical ages to stratigraphic boundaries are shown in Fig. 3. The stratigraphic subdivisions follow the scheme proposed by Weiss (1889) and modified by many workers, including Falke (1954), Atzbach and Schwab (1971), Boy and Fichter (1988) and Schäfer (1986, 1989).

The extent and distribution of the Westphalian and Stephanian successions, and particularly the coal measures successions, have been defined by macrofloras and palynology (e.g. Helby 1966; Germer et al. 1968). The Rotliegend has been more difficult to subdivide using macrofloras and palynology (e.g. Visscher et al. 1974) even though the plant macrofossils were described early this century (Schuster 1907). Boy and Fichter (1988; and earlier papers) described the stratigraphy of the Upper Rotliegend formations (Nahe Group) in the Saar-Nahe Basin, but were only able to divide the 12 Autunian and Saxonian lithological formations into four biozones based on the vertical distribution of tetrapod tracks, and into eight biozones based on Conchostraca. They demonstrated that deposition of the Kreuznach Formation ceased some time before deposition of the Zechstein commenced elsewhere in western Europe, and they also concluded that the Autunian-Saxonian boundary is situated in the upper Grenzlager Formation (Fig. 3).