Gravimetric and magnetic constraints on the structure and composition of the crust of the Upper Rhine Graben area: a strong Variscan inheritance.

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In gravity maps the northern and southern URG show contrasting features. The negative anomalies due to the density contrast between the Tertiary-Quaternary sedimentary infill and the surrounding Paleozoic and Mesozoic basement are less pronounced in the south than in the north of the graben. This is mainly due the absence of Aquitanian sediments in the uplifted south. Because of strong density variations within the Paleozoic basement, negative anomalies are not systematically associated with the sedimentary infill. This is illustrated in the centre of the URG where the Rastatt trough is characterized by more than 3000 m of Tertiary sediments but shows an unexpected moderate gravity high whereas more west, the Haguenau-Landau horst shows a prominent gravity low instead of an expected gravity high or intermediate anomaly. The derivative maps and the gravity map obtained after removing the gravity effect of the graben infill show that the NE-SW anomalies of the northern and central area as well as the E-W anomalies of the south, which all have a Variscan origin, are cut by a series of elongated anomalies and discontinuities striking N30-40°. Part of these gravimetric anomalies coincides also with magnetic anomalies. The latter belong to a 550 km long, 60 km wide belt of strong magnetic anomalies which in outcrops are due to arc magmatic rocks emplaced in the time range 340-330 Ma, during subduction of the Rhenohercynian ocean beneath the Saxothuringian – Tepla-Barrandian continental crust. A second magmatic arc of slightly older age (345-337 Ma) and striking E-W, also characterized by prominent magnetic anomalies, crosses the southernmost URG area.

The NE-SW trending discontinuities and elongated structures which obliquely cross the pre -Visean basement, are identified in outcrops in the Vosges, Black Forest, and the Odenwald Mountains. They form a 40 km wide, N30-40° striking, sinistral wrench-zone that, in the Visean, shifted the Variscan and pre-Variscan structures by at least 43 km to the NE. Wrenching along the Upper Rhine Shear Zone (URSZ) was associated with emplacement of several generations of plutonic bodies in the time range 340-325 Ma. The sub-vertical, NE-SW trending discontinuities in the basement acted as zones of weakness, susceptible to reactivation by subsequent tectonism. The first reactivation, marked by mineralizations and palaeomagnetic overprinting along NE-SW faults of the Vosges Mountains, results from the Liassic NW-SE extension contemporaneous with the break-up of Pangea. The major reactivation occurred during the Late Eocene N-S compression and the Early - Middle Oligocene E-W extension. The NE-SW striking basement discontinuities were successively reactivated as sinistral strike-slip faults associated with pull-aparts, and as oblique normal faults. Elongated depocentres appear to form in association with reactivated Variscan wrench faults. Some of the recent earthquakes are located on NE-SW striking Variscan fault zones, and show sinistral strike-slip focal mechanisms with the same direction, suggesting also present reactivation.

The geological basement map derived from processed gravity and magnetic maps and geological constraints demonstrates that from the Armorican Massif to the Bohemian Massif the URSZ was the unique candidate for graben tectonics during the Tertiary E-W extension.