DETERMINATION OF SITE MOTIONS IN THE VICINITY OF THE ERFT FAULT IN THE LOWER RHINE EMBAYMENT

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Abstract
The intensive brown coal mining activities occurring since the mid-fifties of the last century in the Lower Rhine Embayment have caused massive landscape changes in these areas. Less obvious but equally dramatic are the effects on the earth's surface such as soil movements which are mainly due to groundwater withdrawal associated with the open-pit mining activities. Larger discontinuities in the pattern of motion tend to appear at pre-existing fault lines and are causing sizable damage to buildings and roads.
Precision levelling carried out by the survey administration in regular intervals, and in recent years also GPS, are being used to measure these motions and monitor their behaviour with high precision. As a recent example, the measurements in the local area deformation network "Donatussprung", which is a part of the Erft Fault System where its surface trace can easily be identified from topography and effects on buildings and roads, have yielded displacements of up to 5 mm/yr in horizontal and 20 mm/yr in vertical direction. Vertical and horizontal motions due to recent tectonics are much smaller by at least an order of magnitude.
The highly significant pattern of vertical and horizontal vectors shows a striking dissimilarity in the motion of groups of points on either side of the fault. Velocities are largest on the western side of the fault. Furthermore horizontal velocities tend to decrease with increasing distance from the fault, whereas vertical velocities become larger with increasing distance. The scenario suggested by these measurements indicates that the Erft Block at its rim is not following the overall subsidence that is observed at some distance away from the fault. Possible interpretations are also discussed.

1. Introduction

At least one third of the ground surface of Northrhine-Westfalia is affected by ground motions, due to both recent tectonics as well as mining (see Fig. 1). The Lower Rhine Embayment as a part of the West European Rift Belt is known for its present-day seismo-tectonic activity. The rift system characterises the weak crustal zone of northwest Germany and the Netherlands. It continues in the directions of the Alps and the North Sea respectively. The active faults run from the NW to the SE. One special section of the Erft Fault System in the region located south-west of Cologne can be easily

Figure 1: Open-pit brown coal mining near Cologne

identified by topography and the effects on buildings and roads (see Fig. 3). In the immediate vicinity of the surface trace of the so-called “Donatussprung” which separates the Erft-Block from the Köln-Block (Ville), a local area GPS network has been established (Fig. 2). The vertical and horizontal motions due to ongoing tectonic forcing are estimated to be much smaller than the effects due to the open pit mining activities, since parts of the region are strongly influenced by ground water withdrawal down to some 100 m associated with the extensive brown coal mining. In or near brown coal mining areas groundwater withdrawal produces subsidence of up to 2 cm/year in the area under investigation.

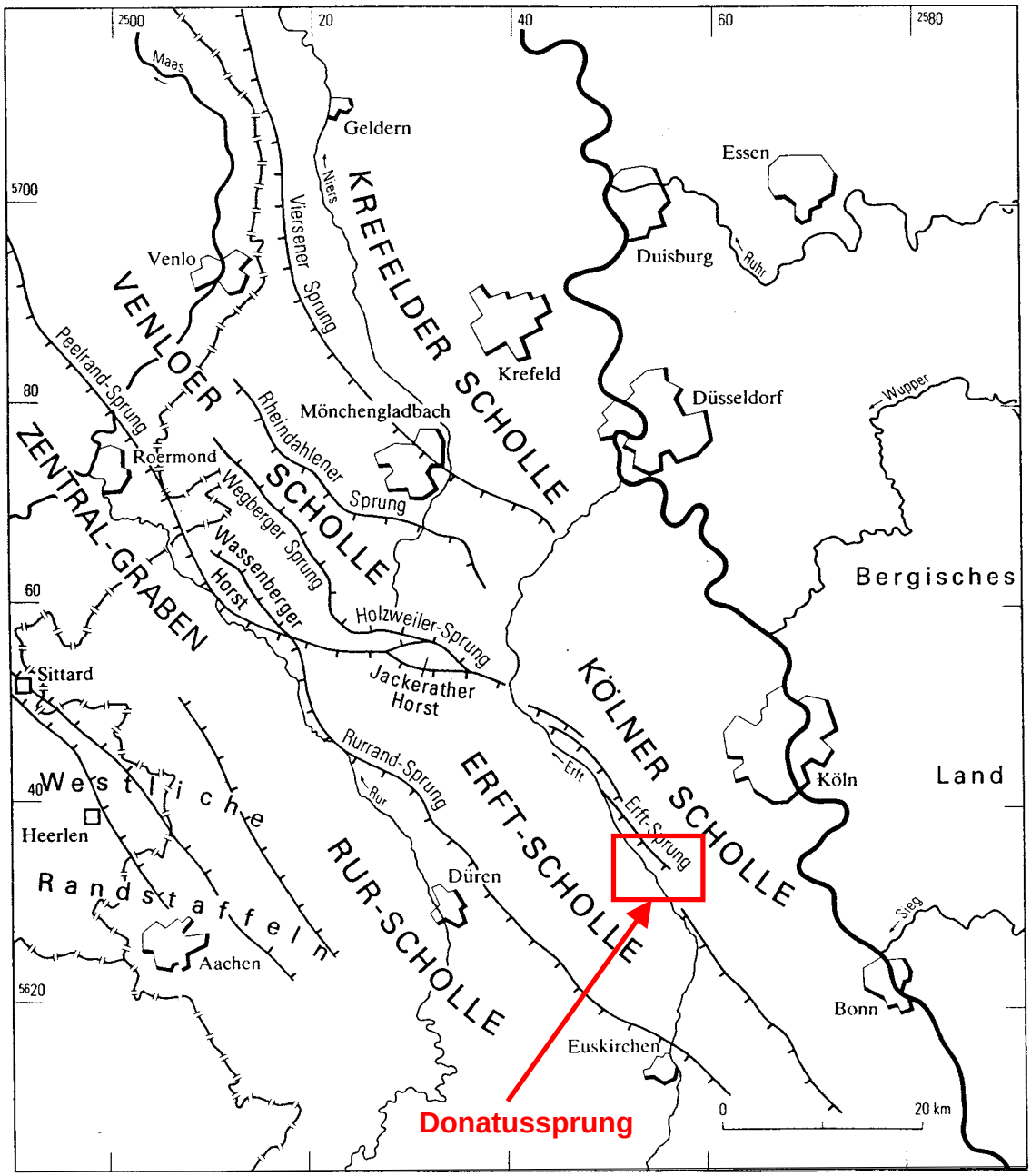

Figure 2: Geological sketch map of the Lower Rhine Embayment [4]. The red square denotes the area under investigation in the vicinity of the Donatussprung