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deformation during the folding of the Jura Mountains and the Chaînes Subalpines in the Pliocene.

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Present state of stress in the Swiss Molasse Basin

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Stress measurements in the Swiss Basin are carried out with different techniques but their number is very limited. Data exists from fault plane solutions of earthquakes, overcoring measurements and breakout studies in deep boreholes. Results from hydraulic fracturing experiments do not exist for the Swiss Molasse Basin but a number

of measurements are available from the Wellenberg area south of the Molasse Basin where Nagra is currently carrying out site investigations. The overcoring data were gathered in the area between Basel, Zürich and Luzern and are restricted to shallow boreholes. The direction of the maximum horizontal stress determined by this method is about N 150° E. Additional data are available from breakout studies in 13 wells. Six wells are located northwest of Zürich, four in the area between Luzern and Bern, two near Lausanne and one northeast of Zürich. These studies show a change of stress orientation with depth. In addition there seems to be a relation to the following units: molasse basin sediments, permo-carboniferous trough and crystalline basement. The stress direction inferred for the basement closely corresponds to the results derived from fault plane solutions of earthquakes. We observe a direction of about N 145° E which is in good agreement with the mean orientation of the stress field in Western Europe. Different orientations are seen in the permo-carboniferous trough (N 160° E) and in the Molasse Basin south of the folded Jura Mountains. Here an orientation more or less in N-S direction is predominant.

South of the Molasse in the Wellenberg area (between Stans and Engelberg) hydrofrac measurements indicate a stress direction of N 135° E. These investigations also allow the determination of the stress magnitude. The horizontal stresses were measured up to a depth of about 1100 m. It was shown that the maximum horizontal stress (SH) is about 2 * SV (vertical stress). The minimum stress (Sh) is approximately equal to SV.

Geodetic Measurements in Northern Switzerland and neighbouring regions

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The following geodetic measurement campaigns were carried out as part of Nagra's neotectonic investigation programme in Northern Switzerland:

- Analysis of levelling measurements in Northern Switzerland (NTB 84-17)
- Extension of the above campaign to cover an area of the Southern Black Forest and an adjacent region to the east as far as Lake Constance (NTB 88-05)
- Geodetic measurements in the Hauenstein Tunnel and over the Hauenstein Pass
- GPS (Global Positioning System) network for Northern Switzerland (Wiget et al. 1991)

Analysis of levelling measurements in Northern Switzerland: For the area between Wildegg and Baden in the northeastern part of the Folded Jura, the results of the analysis indicate uplift velocities between 0.1 and 0.4 mm/a (height changes relative to a reference point at Laufenburg). In the same region, but to the north of the Folded Jura, the measurements show a more or less exclusive tendency towards subsidence.

Extension of the above campaign to cover a larger area of the Southern Black Forest and an adjacent region to the east as far as Lake Constance: This study indicates uplifts