Thickness and signature estimation of the SE1 seismic event at the KTB Oberpfalz

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The initial evaluation of the 3D seismic reflection data set at the KTB Oberpfalz (ISO89) had to be based on an intermediate step of data processing due to the strong lateral heterogeneities of the crystalline basement. The required so-called envelope stack and the subsequent map migration yielded depth values providing a relatively high degree of reliability, already. Amongst others the top zone of the SE1 event could be estimated by different methods and interpreters to be in the range of approximately 6,600 m to 7,000 m. The related dip was determined to about 55° with 320° strike. The error bounds of the different depth estimation methods including the observation error amount to ± 140 m. For references and further details see DEKORP RESEARCH GROUP in KTB Report 92-5 'DEKORP Report', WIEDERHOLD ib., STILLER and TORMANN ib., STILLER ib. and HIRSCHMANN ib.

The KTB drilling results indicated with high reliability that the top zone of the SE1 was reached at 6,750 or 6,850 m depth. However, careful additional analysis is necessary to determine the depth of its top accurately. Then, a reliable modification of the seismic velocity model will be feasible and the depths of the deeper reflectors can be better estimated. For this purpose and for the sake of better resolution and distinction between separate interfering events the evaluation of the phase-consistent stack is strongly necessary. But this stacking method had to be based on important information from the envelope stack. Therefore, it has been completed just recently by the DEKORP Processing Center so that its evaluation is still in progress. Moreover, a 3D wavefield migration or at least a map migration of these data is required to exclude remaining ambiguities.

Comparison between drilling results and seismic reflection observations at the KTB gives evidence that fault zones are responsible for the reflections in nearly most cases (Table 1). I.e. geological data at the surface indicate clearly that lithological boundaries do not appear as linearly or planarly extended elements, nowhere in the area under discussion. In contrast, the geological map of the Oberpfalz appears as a highly differentiated, randomly distributed patchwork.

The inspection of the data presently at hand yielded that the reflection characteristics and the signature of the more extended reflections varies strongly. Figure 1 demonstrates that the SE1 event generally exhibits a complicated image changing in time and space, respectively. The signature consists of at least three and partly up to five phases indicating a complicated internal structure and a certain extent of the fault zone in normal direction. This effect might be due to changing lithology and/or due to changing tectonic conditions along the fault plane. Possibly to a certain extent it might be explained by changes of the signal waveform effected by different conditions in the hanging wall. In an extreme case we could be dealing with only one sharp jump in seismic impedance. Thus, the following discussion must be considered as an assessment of the maximum thickness of the SE1 fault zone.

Under the assumption that the observed wave signature corresponds to a broad fault zone with an internal structure an initial assessment of the vertical extent (i.e. along the drilling path) yields approximately 570 m at the KTB location. Considering 55° dip a thickness of some 330 m follows in normal direction to the fault plane. For this calculation a p-wave velocity of 6,200 m/s was used

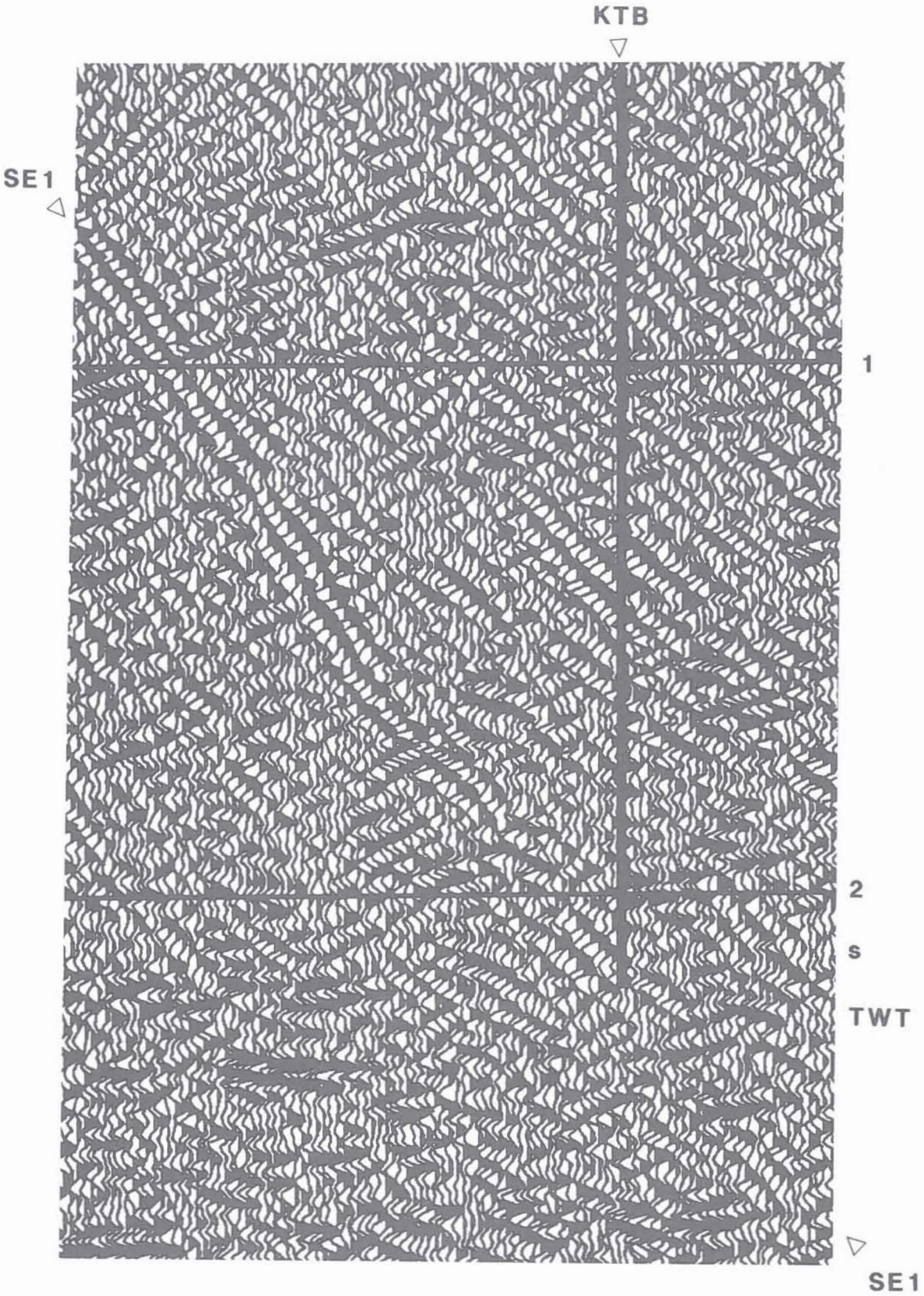

Fig. 1: KTB8502 2D-profile stacked with special regard to steep dips (migrated version)

Table 1: Comparison between drilling and seismic results

Denotation	*Correlation*	*Depth below KTB-HB*
SE2	Klobenreuth Fault	c. 3,550 m
SE12	ambiguous afflux of brines --> fault ?	c. 4,700 m
SE3	bending of foliation --> hinge zone fault ?	c. 5,800 m
SE1	Altenparkstein Fault	c. 6,750 m or 6,850 m (top) c. 7,350 m or 7,450 m (bottom) ?
SE4	Fichtelnaab Fault	geometrical position not reachable

derived from average sonic log observations in the corresponding depth range. Taking into account the appropriate angles of projection, the result matches well to the geological findings at the surface stating an extent of the Franconian Fault Zone of 200 to 400 m.

A second indication for the correctness of our result is the time interval between the first and the second seismic half-phase of the SE1 event at the drilling location (after migration). Using the already mentioned wave velocity of 6,200 m/s a depth interval of 260 m is obtained. It matches well with the depth difference between the top of the fault zone at about 6,850 m and the unaltered gneisses at about 7,140 m (approximately = 290 m).

From this it can be deduced that the lower boundary of the SE1 fault zone might be situated at 7,350 m or 7,450 m depending on the depth defined for its top. Of course, the error bounds of ± 140 m are still to be considered.

One has to take into account that the presented assessments are derived mainly from the 2D profile KTB8502 (Fig. 1) running in dip direction of the SE1 but having a certain offset from the KTB location and disregarding 3D effects. Moreover, the exact original seismic wavelet is not known implying that we are dealing with a maximum guess as mentioned above.

To cope with these difficulties an additional seismic experiment is intended aiming at the SE1 event in the domain of its intersection with the KTB drilling. Explosive sources will provide more energy than Vibroseis and a suitably higher frequency content so that the true signature of the reflection under discussion will be - hopefully - detected already in single non-stacked field records. Thereby also disturbing effects of common data processing will be avoided. Furthermore, signal detection techniques will be applied in order to separate the single wavelet statistically and to reveal subsequently the internal structure of the SE1 if there is any. Initial tests with data from the KTB8506 profile produced good results already.