Geophysical Research Abstracts, Vol. 7, 02967, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02967

Compilation And Picking Of 3-Component Seismic Profiles

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Seismic refraction and wide-angle reflection surveys using mine blasts are a cheap and effective means of determining the velocity structure of the Earth's crust. A programme of this type is currently being undertaken in the southwest of Western Australia. The logistics of such surveys, where survey lines stretch over hundreds of kilometres, may be simplified if they are carried out in multiple overlapping deployments. Deployments overlap at one, at most two, reference stations. These reference stations are the only means of constructing a single profile, as it is impractical, due to logistics of deployments, to always record the source times of various events.

The large offsets mean recordings are made in various environments, from open fields to forests, to urban areas. Noise levels are high in places and there is a need for considerable signal enhancement. Multiple recordings of the same source allow stacking, and recording 3-component data allow the polarisation properties of the data to be exploited for enhancement and picking.

Before stacking and picking can take place a single profile of a blast may need to be constructed from various deployments. This requires the first breaks at reference stations to be time aligned. Such task can be performed by cross-correlation, but problems may arise due to presence of the P-wave coda. As a result the first breaks may be misaligned, rendering further stacking and enhancement erroneous. The problem can be overcome by using a function similar to cross-correlation, but based on semblance instead. In either case, the maxima of cross-correlation or a semblance-based function correspond to alignment of traces. Alternatively, polarisation of the P-wave may be used. P-waves exhibit a highly rectilinear motion, whilst seismic noise doesn't. Lin-

earity of the two traces may be computed and their maxima, corresponding to presence of rectilinear motion, aligned. In fact, linearity may be used as a picking procedure on its own.

Variable recording environments result in variable signal to noise (SN) ratio of the data. Parts of the data may need considerable enhancement and different picking procedures may be used in different parts of one single profile. In addition to conventional component-wise Nth-root stacking, 3-component seismic profiles, permit advanced enhancement techniques such as semblance stacking and polarisation and direction filtering.

Picking of 3-component seismic data in good SN ratio parts of the profile may be performed by examination of the linearity of the traces that comprise that part of the profile. Maxima of linearity coincide with the first breaks of the P-wave. In parts with poor SN ratio a noise tolerant algorithm is required. One such algorithm is based on estimation of the fractal dimension of a seismic trace. Its major advantage is that it can handle noise levels up to 80% of the signal level making it one of the most robust picking techniques.

These procedures are demonstrated on a seismic reflection profile recorded in the west of the Yilgarn Craton, in the southwest of Western Australia.