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Reply to: Comment on 'A case example of near-surface correction for multicomponent VSPS' by Gildas Omnes[1]

Colin MacBeth[2]

It is indeed correct to be concerned over time picks which are taken to the nearest sample. The accuracy of first-arrival picking, investigated by Tariel and Michon (1984), Cliet *et al.* (1989) and Dillon (1994), is an important issue. In principle, for noise-free data uncontaminated by wave interferences and with the entire source spectrum lying below the Nyquist frequency, there are no theoretical reasons why the picking should not be to maximum computer accuracy. In application, the governing factor is then the physical (or automated) action of making the pick. I also agree that such subsample accuracy must be an essential component of the processing stream, but only when considered as part of an iterative procedure such as that suggested by Dillon (1994) to account for the *known* upfield (or other) interference if using 'troughs' and not the first break (Dillon and Collyer 1985). There is ample justification for a more general acceptance of such a practice. Even if arrival times include the inevitable fractional millisecond shifts arising from source signature drift, the borehole and other mechanical components of the acquisition system, the time should still be picked as accurately as possible given the precursory noise, because accurate knowledge of any physical parameter, *albeit* biased, can only help to improve the overall processing and understanding.

It may also be correct to transfer some of the conclusions from first-arrival picking to the analysis of split shear-waves carried out by Zeng and MacBeth (1997). Here, the method employed was to search for the maximum degree of cross-correlation between the two closely spaced *qS1* and *qS2* waves, after the data had been processed by a near-surface correction and then the shear-waves separated by multicomponent rotation. It is our usual practice to achieve subsample accuracy by re-sampling to a finer interval during the process of cross-correlation analysis. This is a procedure widely used in our in-house shear-wave analysis package (SWAP), and examples of our results can be seen in numerous papers, including those recently published by Horne and MacBeth (1994), MacBeth, Zeng and Queen (1995), and Horne *et al.* (1997). It is unfortunate that the publication in question did not utilize this approach. However, the central objective of the paper was near-surface correction as an aid to proper interpretation of the multicomponent VSP, the conclusions of which remain untouched by this discussion. It is also important to emphasize the differences

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[1]Received February 1997, revision accepted March 1997.
[2]Edinburgh Anisotropy Project, British Geological Survey, Murchison House, West Mains Road, Edinburgh, EH9 3LA, Scotland, UK.

between this time-delay estimation and first-arrival picking, as the former is a relative measure between two wavelets, generally quite small in magnitude (typically a fraction of a sample up to 30 ms). The *qS1-qS2* time-delays are greatly influenced by small variations in the *qS1* and *qS2* wavelet shapes due to, for example, differential dispersion and attenuation. These variations combine with random and coherent noise to exert a strong influence when estimating very small time-delays (generally 5 ms or less). Although this prevents a detailed understanding of the results in terms of the reservoir properties, it does not detract from the general need for an accurate measurement. It is agreed that increased accuracy can only help towards improving the technique for wider use.

In summary, we agree with the general sentiments in the comments made by Gildas Omnes: subsample accuracy should most certainly always be pursued. However, it remains an open issue as to how well the application of such methods can help to define the anisotropy in a thin reservoir: this is really quite specific to the technique used (interval or cumulative), acquisition practice (single or multilevel tool), and the nature of the reservoir heterogeneity itself.

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