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The phase fields concept – qualitative discussion

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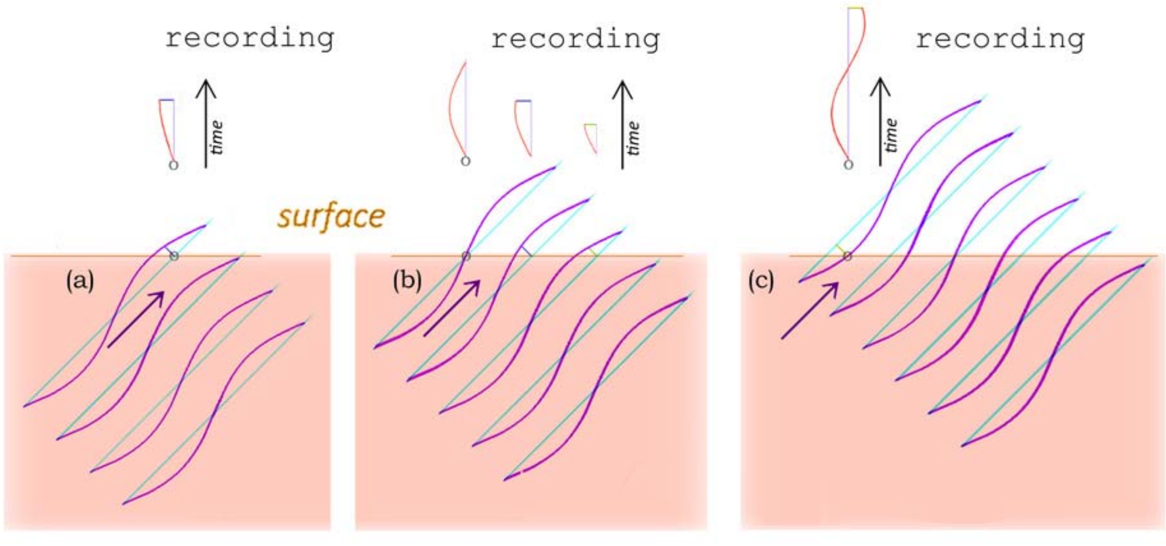
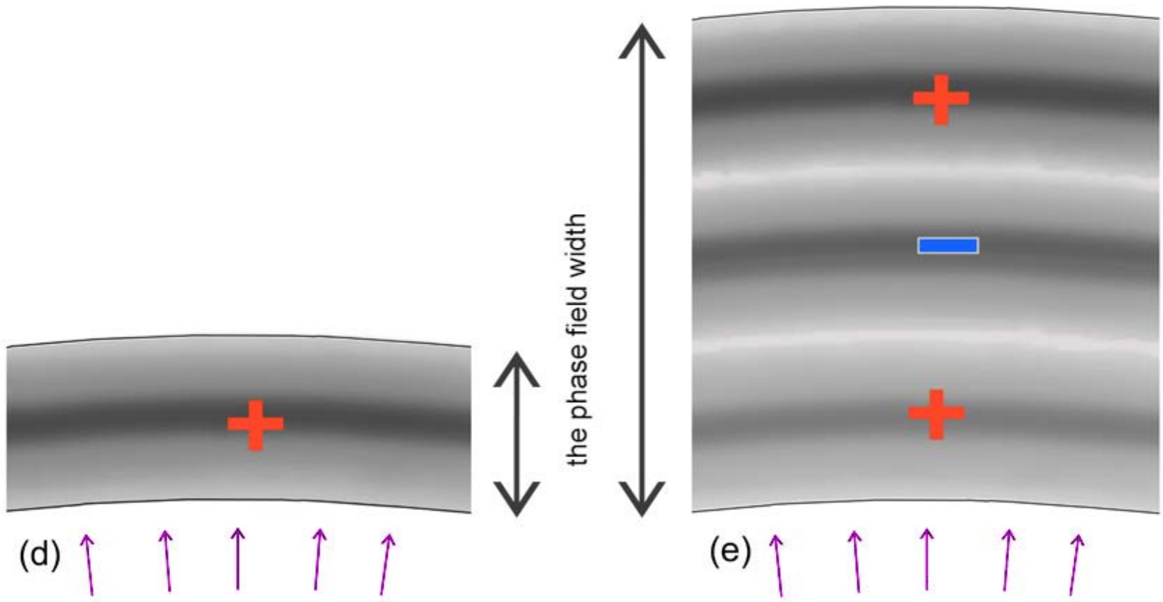
(abstract)

A simple geometrical reasoning leads to conclusion that the expression of any seismic wave, at the surface, is organized. Thus, not only the line a given phase arrived at the same moment is of importance, but also minor details of a wave field are worth study. Such spatial or 2D research should open a path to better understanding the organization of seismic waves and their interactions with the Earth's surface and uppermost layers. These two interrelated problems are especially important for the view on angular motions: at first, on rotations, but also on the so called shear which is in fact a *shape strain* (angular, and symmetric one), not just the strain/motion perpendicular to the direction of propagation. It should be remembered that propagation of rotations and their sign in neighbouring places do not belong to really solved problems, both at the micro and macro scale, at the latter – the field measurements may help. Besides, such studies shall improve researchers' knowledge in practical cases.

The expression areas of individual kinds of seismic wave motion, here named *the phase fields*, supposedly differ for each frequency band. It is known that very similar rotation affects relatively large areas at the same while – see Suryanto *et al*. (2006). Also the problem of border of the phase field, of given type, may be interesting. Schemes (a), (b) and (c) relate to situation where a bundle of approximately parallel waves reaches the Earth surface, and the contact starts in the point marked with small circle. These three pictures illustrate the same imaginary episode in time sequence, in the cross section.



In the moment (a), only initial part of the wave has passed through measuring site, as the sketch of obtained record shows. In (b), maximum of first wavelet that reached surface has moved to the right and the record at “circle” embraced first half of the wave. We see that when the wave arrives obliquely at the surface, the width (proposed term) of its *phase field* should depend not only on the wave length but also on the arrival angle. In (c) almost full wave length is recorded. (If there were installed a line of sensors along the projection of wave vector on the surface, simultaneous indications from these devices would reflect the incoming waves (provided that that they are of identical form)).



Scheme (d) shows the same moment as (b) but viewed from above. Phase field has now a shape of belt; its width is along the projection of wave vector (arrows), and its length may be large – it depends on regional tectonics and the location and parameters of the source. But the wave bundle usually has big depth; in result – parallel belts should develop and move in surface along projection(s) of the propagation of incoming waves. Their signs should alternate and of course maximal amplitudes may vary, as the consecutive wavelets will be represented – see the scheme (e).

Pictures should be dynamic: in given part OF THE SURFACE, after maximum of the wave expression, the peak zone moves forward, central zone of the same area shall “bleach” and the opposite phase already follows.

To study 2D expression of seismic waves at surface, the dense array of sensors is needed. It should consists of 3C sensors, or better 6C (with three rotation components), or extensometers. Mixed arrays can also be used, but then the intercalibration problems will rise. Probably the cases (parts of the obtained waveforms) where superimposing phases collide should be avoided, until the resolution process will be perfected. It may be added that if not only motions/strains in horizontal planes were taken into account, but also those which occur in vertical planes, schemes would be much more complex due to effects of reflection at the half space surface.

We are all interested mainly in the angular motions , but the rectilinear motions' phase fields are also of interest, as they complete the picture. First of all, the body waves in the far field conditions should be studied, as the easiest example.

Reference

Suryanto, W., H. Igel, J. Wassermann, A. Cochard, B.S.A. Schuberth, D. Vollmer, F. Scherbaum, U. Schreiber, A. Velikoseltsev (2006). First comparison of array-derived rotational ground motions with direct ring laser measurements, *Bull. Seismol. Soc. Am*. **96**, 2059-2071.