# Models of the electromagnetic field formation associated with earthquakes due to the piezoelectricity of quartz.

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Piezoelectricity of quartz is proposed as a formation model of electromagnetic phenomena associated with earthquakes (SES). However, a problem is pointed that electric polarization from randomly oriented quartz will be cancelled to zero. What kind of mechanisms are possible to solve this difficulty? Some models will be shown with the procedure to verification.

1: rectification in earth
2: fluctuation of the random orientation
3: macroscopic chirality of quartz
4: orientation of +a-axis
5: polarization due to stress gradient
5': abnormal piezoelectricity
Stress gradient can form electric polarization in conductive matters
5'-1: streaming potential
5'-2: deformation potential

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1: rectification in earth

Randomly phased charge-compensating current may be rectified in crust. Inhomogeneous rocks may have electrochemical rectification[2].

2: fluctuation of the random orientation

Random orientation of N particles can have the fluctuation of about root N.

See the previous report by Ikeya[3].

3: macroscopic chirality of quartz

There are left-handed and right-handed quartz in nature. If one type exceeds the other[6], and if there is c-axis orientation[4,5] in a rock, it has shear piezoelectricity.

4: orientation of +a-axis

It is difficult to distinct the sign of a-axis[7]. More, we have to distinct the orientation from the fluctuation. Physical mechanisms should be investigated to limit the samples to be searched.

5: polarization due to stress gradient

Even the rock with a center of symmetry can have electric polarization under a stress gradient in principal.

The strehgth of quartz is anisotropic and obeys the trigonal symmetry[8]. If a crack parallel to the b-plane has anisotropic strength between + and - a direction, the strength depends on the direction of a-axis in stress gradient. Such effect forms macroscopic polarization.

6: abnormal piezoelectricity

Stress gradient can form electric polarization in conductive matters

6-1: streaming potential[9]

6-2: deformation potential[10]

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