paracetamol, do not interfere in this method. Following compounds which may be of interest to Forensic Toxicologists, also do not interfere in this method : acetanilide, *p*-nitrophenol, *p*-nitraniline, *p*-nitrochlorobenzene, sulphadzine, sulphamethazine and sulphamerazine. *p*-aminophenol, a metabolite of paracetamol interfere in this reaction which is not extracted during the acidic chloroform extract procedure. The method is found useful for the determination of paracetamol from biological samples. The *in vitro* recovery of added paracetamol to various biological specimens is found to be between 97 to 99% (Table I).

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A NEW TECHNIQUE FOR THE STUDY OF PIEZOELECTRIC PROSPECTING ANOMALIES OVER MODELS'

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Abstract

Development of the piezoelectric method as a geophysical prospecting tool needs a practical technique for the evaluation of the piezoelectric activity (PEA) of geological formations. A simple method which makes use of a transient mechanical impulse was utilised in the present study for obtaining a PEA profile across a model quartz vein under laboratory conditions. Besides simplicity, the suggested method offers some practical advantages over existing techniques. The results indicate that a measurable anomaly is obtained over the vein, and that the characteristics of the signal recorded are related to body parameters.

Introduction

THE phenomenon of piezoelectricity of materials, first discovered in the late eighteenth century by the Curie brothers[1,2] presently finds wide application in electronic and related industries. It manifests as electrical polarization in a dielectric when subjected to a mechanical force. Attempts are being made now to adopt this property for geophysical prospecting purposes, *viz.*, for locating vein quartz, other piezomaterials and associated minerals[3,4].

While the piezoelectric effect is restricted to dielectrics and among them to such crystalline materials as those lacking in a centre of symmetry, many geological specimens were found to display this property[4-6].

A constant of proportionality, known as the piezoelectric modulus which relates the electrical polarization intensity with the applied mechanical stress, is generally used to characterize the PEA of substances. For common geological materials, the modulus was reported to vary from $1\cdot 3 \times 10^{-11}$ to $6\cdot 8 \times 10^{-8}$ cgse unit. However, majority of the work on the PEA of geological formations was carried out abroad and data on Indian specimens is practically non existent.

The development of the piezoelectric method as a prospecting tool in Indian conditions needs *a priori* knowledge of not only the PEA of Indian rocks but also the response of the method in different geological settings.

Laboratory determinations of the PEA modulus and modelling work over PEA bodies as carried out by various workers till now depended upon either the static loading of the sample or continuous excitation of the sample by high frequency vibration[4,7]. Such techniques require elaborate instrumentation consisting of sample holders, signal generators, transducers, electrometers, machinery for creating directional stress, etc. Both the above techniques are not related to observational procedures in the field[3,5], where an impulsive signal (using either an explosive source or a weight drop) is created in the earth to generate elastic waves which while passing through a piezoelectrically active body produce electrical signals of varying intensity and frequency depending on the physical and geometric parameters of the body.

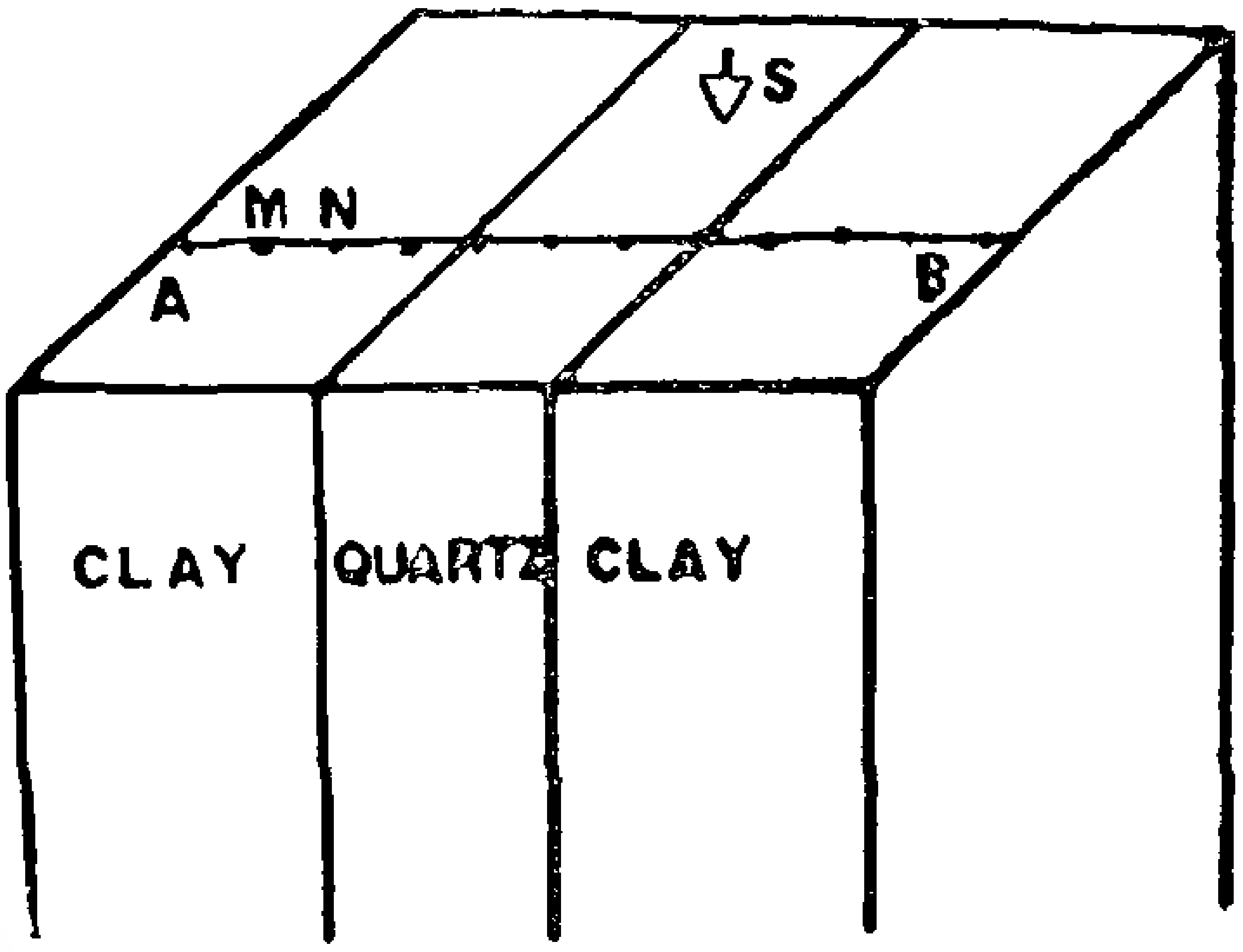
Thus, it is seen that the existing techniques need to be modified both for reasons of analogy with field conditions as well as for ease of operation. In this paper the authors propose a simple technique for determining the PEA of rock formations, which is well suited for model studies as well as for field surveys.

The proposed technique consists of creating a transient mechanical signal in the rock sample which, if piezoelectric, in turn causes a proportional electrical signal in it. The electrical signal is picked up by two electrodes kept in contact with the sample and is recorded.

FIG. 1. The model set up for Piezoelectric Prospecting.

The experimental set up is shown in Fig. 1. During the present work using the above set up, the response of a model quartz vein embedded in a highly conductive and non-piezoelectric material was examined. The model consisted of a sample of vein quartz (40 × 20 × 20 cm), embedded in a clay matrix and placed in a cement tank.

A transient mechanical signal was generated by dropping a weight (spherical iron ball of 129 gm) on the rock sample from a fixed height (60 cm). The resultant electrical signal was picked up through two measuring electrodes, 10 cm apart and located on a profile at a distance of 12 cm from the point of impact and recorded on a storage oscilloscope, through an impedance matching circuit. The schematic diagram of the set up is shown in Fig. 2.



S—Point of impact or shot point; MN—measuring electrodes; AB—Profile along which the electrodes are moved and measurements are made.

FIG. 2. Schematic diagram of the model.

The weight dropping was always carried out at the same spot on the sample. Observations were carried out by moving the electrodes in steps of 5 cm along a profile crossing the rock sample and continuing on either side into the clay. At every point of observation repeat weight drops were used to ascertain the nature of the signal, its repeatability and to discriminate it against noise, if any.

Fig. 3 *a* shows a reproduction of the record of the electrical signal on the storage oscilloscope. The amplitude of the first peak of the electrical signal recorded is taken as the amplitude of the signal. In Fig. 3 *b* are plotted the magnitude of the electrical signal at different observational points (but for the same point of impact) along the profile crossing the model quartz vein. As can be seen from the figure, the electrical signal is low and is almost constant over clay on either side of the vein. But as the body is approached the signal rises gradually from 0·2 V in clay to 2·5 V exactly over the centre of the quartz vein, where after it gradually decreases.

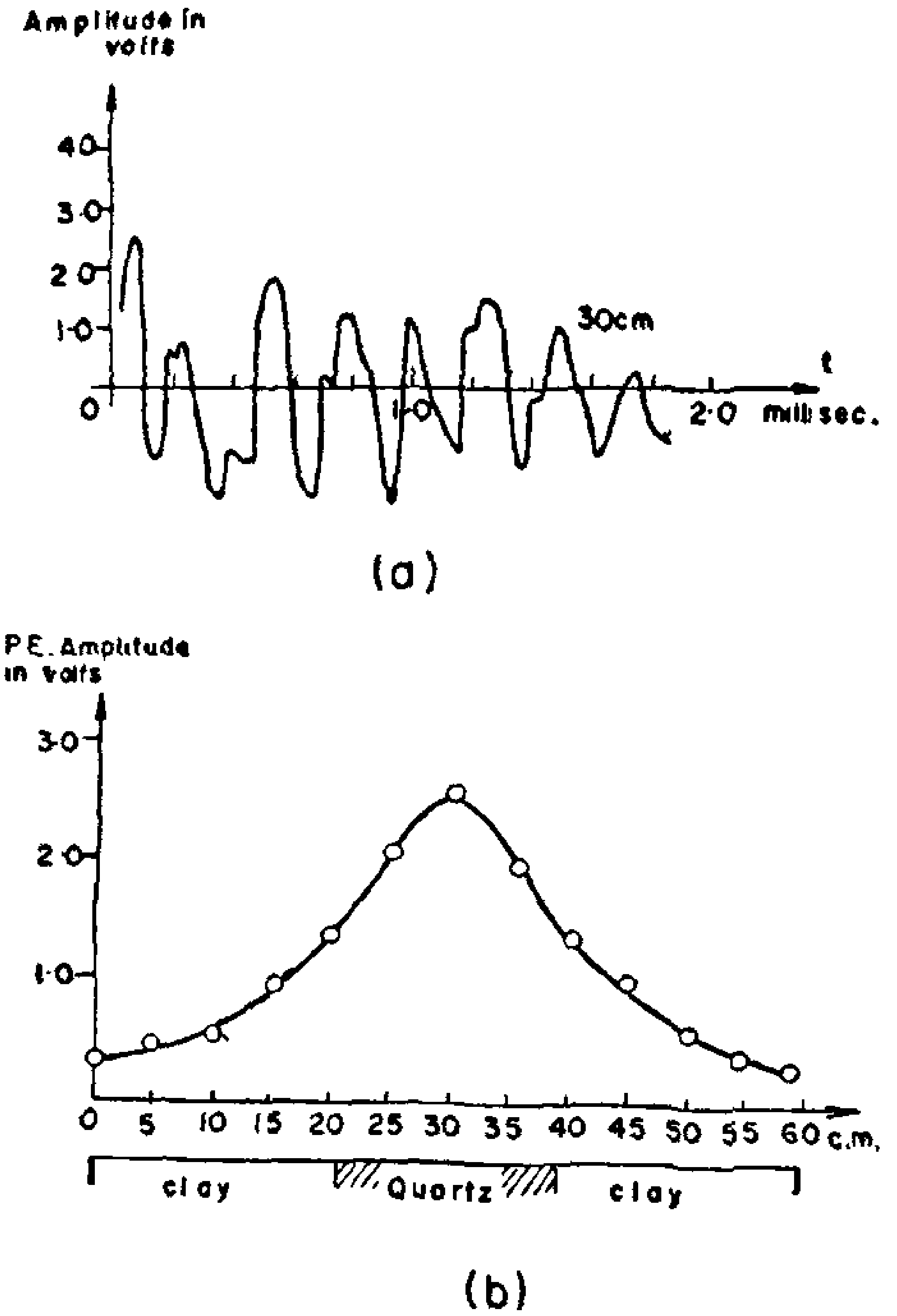


FIG. 3. Piezoelectric anomaly over the model *quartz vein.*

(*a*) Record of the electrical signal. (*b*) P.E. amplitude curve over vein quartz in clay medium.

Similar results have been observed over quartz vein of different thicknesses. In each of these cases the width of the anomaly has significant relation to the thickness of the quartz vein. Quantitative analysis of the data showed that the distance between points having a magnitude equal to half the maximum anomaly is of the order of 1·5–2·0 times the width of the quartz vein.

The traces of the electrical signals on the storage oscillograph at different observational points show that in addition to the signal amplitude, the rate of attenuation of the signal as well as signal frequency appear to be related to the physical and geometric parameters of the body. Detailed investigations in this direction are in progress.

The technique proposed during the present work has certain decisive advantages over those used hitherto.

1. The present technique is simpler and facilitates easier observations.
2. The sample is not subjected to forced vibrations at any selected frequency (as was the case in some techniques) but can vibrate at its natural frequency, thus providing optimal conditions for recording. This also means that the frequencies of excitation and recording are similar to those used in natural conditions in the field.
3. Being a dynamic method the technique is free from some of the drawbacks of the static method like dependence of the response on loading rate, leakage of electric charge, etc.
4. The technique is equally applicable for rock samples and for modelling with different types of materials.

The modelling experiments carried out in the present work clearly indicate that the present technique can be extended for field applications for locating quartz and pegmatite veins occurring in less piezoelectrically active country rocks.

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