[redacted]

A method for prediction of volcanic eruptions

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The relationship $\dot{\Omega}^{-\alpha}\ddot{\Omega} - A = 0$ describes the behaviour of materials in terminal stages of failure, where Ω is an observable [redacted] *eruption processes at volcanoes, Ω is interpreted in terms of conventional geodetic, seismic or geochemical observations. Manipulation of Ω provides a consistent analytical basis for eruption prediction.*

THE more successful empirical models for predicting volcanic eruptions probably have a common foundation in first principles [redacted]

surrounding rock by magma pressure, or by the pressure of volatiles exsolved from magma at various levels, from deep [redacted]

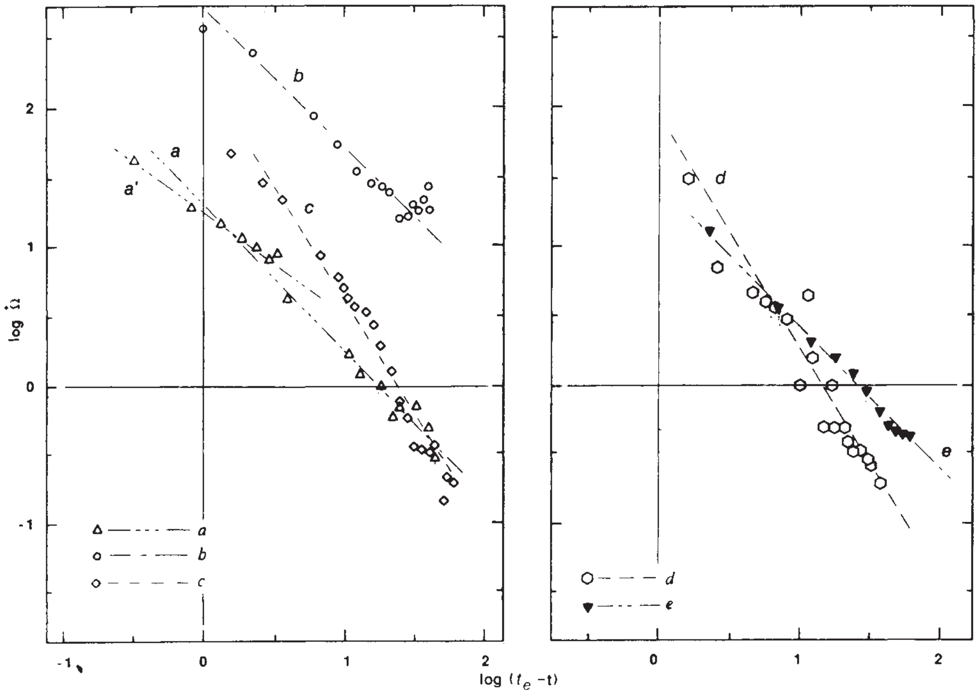
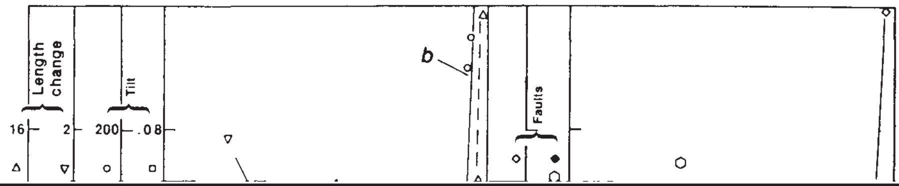


Fig. 3 Relationship between logarithm of rate and logarithm of time preceding eruption or failure. Negative slopes $n = 1/(\alpha - 1)$ for data are as follows: *a*, line length change, Mt St Helens, 1982, $n = 1.04$; *a'*, same, 3 days before eruption, $n = 0.73$; *b*, tilt, Mt St Helens, 1982, $n = 1.0$; *c*, fault, Mt St Helens, 1981, $n \simeq 1.5$; *d*, cumulative seismic strain release, Bezymyanny, $n = 1.66$; *e*, surface movement, Mt Toc, 1963, $n = 1.03$.



Monkman–Grant-type plots ordinarily employ total rupture life rather than time in tertiary creep, an adjustment in timescale

may be necessary for the calculation of equivalent constants.

Applications

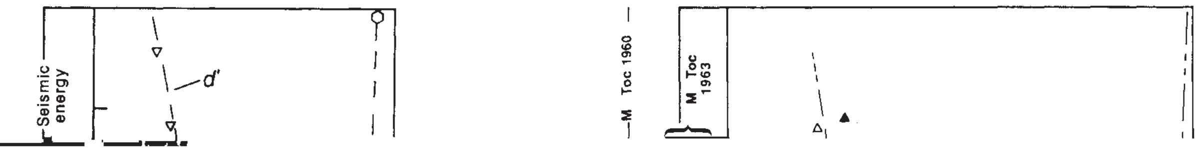
In the following, theory is discussed in relation to three eruptions at Mt St Helens, USA, two eruptions at Bezymyanny Volcano, USSR, and a rockslide at Mt Toc, Italy. The examples

have been chosen to illustrate the manipulation of data from diverse geodetic and seismic observations in order to provide

Helens for the period February–March 1982, for comparison to the distance measurements for the same 19 March eruption of

the previous example, and to illustrate the importance of redundancy and cross-correlation of data in eruption prediction. Both radial and tangential tilt at one station (ROA) resumed in mid-January and accelerated fairly smoothly through March[17]. A break in trend and some irregularity occurred on both curves in early to mid-February.

In curve *b* of Fig. 3, the log rate of tilt (Ω is angular velocity, in μrad per day) is plotted against log $(t_f - t)$. Here too the data


Seismic energy
d'
M Toc 1960
M Toc 1963

there was no scientific consensus on future expectations, and thus no "institutional judgment"[36]. Among alternative outcomes considered were the emplacement of a volcanic dome or a north-flank slide much smaller than that which occurred on 18 May[35,37].

The rate of movement was expected to increase before any

not quite encompassing the actual time to failure at Bezymyanny of ~120 days.

As a predictor, this empirical relationship is only expected to have order-of-magnitude accuracy. Its importance is to focus attention on the inevitability of sector failure of volcanic cones within months if magmatic pressure induces sustained high rates

generally except near the toe. With the available observational data, the method of inverse rate against time could not have been used to predict the occurrence of the 18 May Mount St Helens avalanche; however, a related method seems applicable.

An improved relationship could consider such factors as scale dependency, geometry of loading, lithology, stress and movement history, equivalent viscosity of the magma, intrusion rate, and chamber or conduit geometry. The scale effect, for example,