GL03535

Comments on a Paper by Ki-iti Horai and Amos Nur, 'Relationship among Terrestrial Heat Flow, Thermal Conductivity, and Geothermal Gradient'

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Horai and Nur [1970] have found significant correlation between terrestrial heat flow and thermal conductivity. Previously *Roy et al.* [1968] and *Lachenbruch* [1968] have demonstrated a linear relationship between heat flow and heat production. From these two findings Horai and Nur seem to hypothesize that thermal conductivity and heat generation may be related.

It seems to me that this is unnecessary. The observed correlation coefficient between thermal conductivity and heat flow may be explained as a consequence of heat flow in a random medium. The present writer [*Naidu*, 1970] has worked out a theory of heat flow through a first-order random medium. Expressions for cross correlation between thermal conductivity and thermal gradient under different geological conditions have been derived.

On the basis of this theory the correlation coefficients reported by Horai and Nur were analyzed to test whether the observed variations in the correlation coefficient are purely statistical, owing to finite data. The correlation coefficients are plotted as a function of the sample length in Figure 1. The theoretically predicted correlation coefficient (0.4) is shown by a horizontal line. This corresponds to $\alpha/\beta = 0.064$, where α and β are defined as follows: Let the spectrum of the random conductivity be given by a band-limited function

$$S(u, v, w) = \text{const} \quad \text{when} \quad (u^2 + v^2)^{1/2}$$
$$\leq \alpha, \quad |w| \leq \beta$$
$$S(u, v, w) = 0 \quad \text{otherwise}$$

The 95% confidence lines are also shown in Figure 1; we notice that the majority of the points lie within the confidence limits. The theory, however, does not explain some extremely high correlation coefficients observed for short sample lengths.
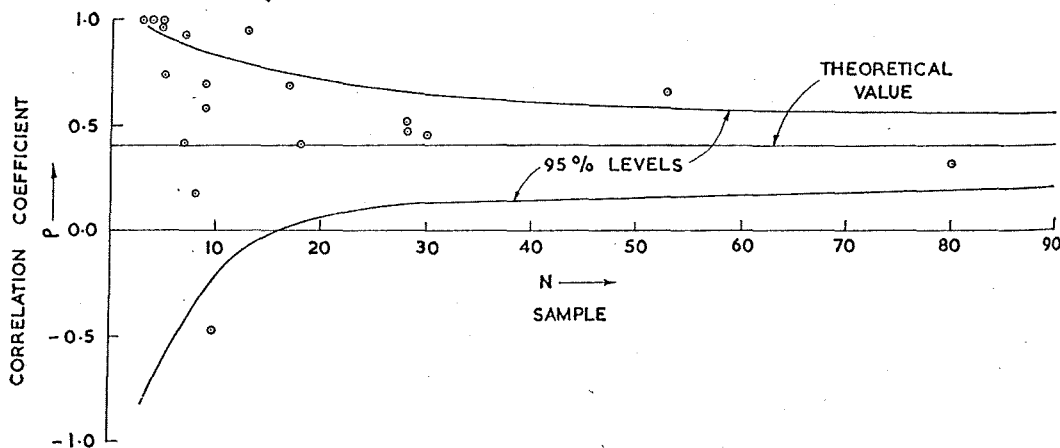
Finally, it must be emphasized that this does not preclude the possibility [ ] ductivity being related to heat [ ] this is not necessary to expla[ ] correlation between thermal c[ ] heat flow.

REFERENCES

Horai, Ki-Iti, and Amos Nur, R[ ] terrestrial heat flow, thermal [ ] geothermal gradient, *J. Geoph*[ ] 1991, 1970.

Fig. 1. Computed correlation coefficients as a function of sample length N. The theoretical value as well as the 95% confidence levels are shown.

'Relationship among
Geothermal Gradient'

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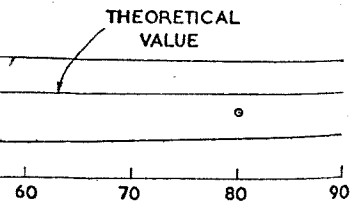
not preclude the possibility of thermal con-
ductivity being related to heat production, but
this is not necessary to explain the significant
correlation between thermal conductivity and
heat flow.

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THEORETICAL VALUE

60   70   80   90

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