

NOTES

LANDSCAPE EVOLUTION AND TWIDALE'S REVIEW OF LESTER KING'S 'CANONS'

On certain occasions, reviewers of earlier contributions in the field of religion, philosophy and social life, draw our attention to the relevance of the earlier teachings, concepts and practices to the modern times also. It is not uncommon to note that in science, as it progresses, thanks particularly to advances in techniques and instrumentation coupled with inputs from many related fields, some of the well-known concepts and laws get to be abandoned or modified. In the present case, Twidale ["Canons" revisited and reviewed Lester King's views of landscape evolution considered 50 years later, *GSA Bulletin*, v 115(10), pp 1155-1172, 2003] has made an attempt to see how far the 'canons' of Lester King, put forth about half a century ago (*Canons of landscape evolution*, *GSA Bulletin*, v 64, pp 721-752, 1953), to explain the variations in landscape evolution, are valid now.

Today scientists are not satisfied with theories or concepts that are mere generalizations based on just field observations alone. To the extent possible, these are expected to be substantiated by field, and in some cases by laboratory experiments, if they are necessary, to be firmly established and accepted. Even here, it cannot be said that these additional evidences present a final solution. For example, attention may now be drawn to a recent paper by Peter Molnar (*Nature*, nurture and landscape, *Nature*, v426, pp 612-614, 11 December 2003), who analyses the results and inferences arrived at by those attempting to establish correlation between precipitation, neotectonics, gradient and stream power, in different parts of the world. He comes to the conclusion that the contradictory relationships arrived at only exposes the inadequacy of current theories at present dealing with erosion rates of streams.

William Morris Davis's (1850-1934) concepts and explanations of the evolution of landforms, to some extent based on the earlier contributions of Powell, Gilbert and Dutton in North America, held sway among geomorphologists in the western world during the first half of the 20th century. However, limited but effective opposition came from Walther Penck and his followers in Europe. To Davis, the stages in the evolution of landforms were largely results of subaerial erosion on a relatively stable mass. But Penck related them to tectonic history of the region. This can be seen in the contrasting explanations they offered to the evolution and shapes of valley sides. It was

during this period that Lester King's 'canons' came into prominence because of its fresh bold approach and novel conclusions, based on studies mainly in a southern continent, namely Africa.

One of the 'canons' of King, dealing with scarp retreat with a free face as an almost universal phenomenon in landscape evolution, is refuted by the author, by citing studies in other parts of the world, where such a feature is not always present in different terrains. To King, all pediments are cut bedrock surfaces resulting in pedimentation, though features similar to these result from other processes, with different amounts of cover of regolith or transported sediments, over the pediments. The suggestion of King that it is the change of process in the flow of running water from turbulent flow in the hillslope to laminar flow in the pediment is also questioned. Whereas scarps do recede, but the plains left behind are not necessarily always pediplains.

King considered the semi-arid environment as the 'normal' and derived all landforms as resulting from processes therein, though he was not unaware of glacial environments producing contrasting landforms of erosion and deposition unrelated to the above processes.

Tectonic and biotic influences cannot be brushed aside as "accidents," as Quaternary geology of many regions presents very many changes due to climate, eustasy and neotectonics, during less than a period of 2 million years and any landform would be affected by these factors as well.

Perhaps King exceeded in his flight of imagination in trying to correlate world's plainlands (*Quart Jour Geol Soc London*, v 106, pp 101-131, 1950) particularly in the southern hemisphere, as formed during certain specific intervals of time from the Jurassic onwards. Recent detailed studies in each of those continents negate this view. Of course, it is said that King was aware of this and was only 'stirring the pot' and wanted to see the reaction from fellow geomorphologists.

After conceding that King's contributions were applicable in certain areas only, and pointing out his errors of judgement in trying to make the 'canons' as generally applicable to many situations, Twidale now attempts in this review to introduce the "New Technologies" that have revolutionised our concepts in geomorphology. This is mainly due to advances in technology leading to dating of

materials and events, studying processes in the field, and statistical analysis of field and laboratory data. Examples of studies in these fields are cited, though it is admitted that each of them has its limitations, because of the magnitude of the problems involved, both in space and time, and it is rather difficult to compartmentalise the effects and causes that lead to the formation and destruction of landforms.

River patterns, on regions of different area! extent, palaeo surfaces, etch forms and exhumed surfaces are dealt with next. Numerous modern studies are cited contradicting our earlier ideas on causes of drainage pattern, river piracy and the dominant control of structure and/or tectonics. Some credit is given to King for his recognition of palaeo surfaces and antiquity of some of them dating back to Cretaceous. Older landforms are better preserved among the Gondwana remnants in the south rather than anywhere in the northern hemisphere, because most parts of the latter were subjected to Pleistocene continental glaciation.

Exhumed landforms are reported from many parts of the world, but are best preserved and revealed when they are covered by volcanics and exhumed, preferably in the Quaternary. They are usually of limited areal extent. It may be mentioned here that in India the best examples are the Vindhyan topography in parts of Central India as revealed after the removal by erosion of the Deccan Traps as the cap rock. Others exist in some of the Precambrian terrain also, but one cannot be very definite about them.

That climate has been changing in different parts of the world is well brought out by examples such as ferruginous regoliths from cool climatic regions in southeastern Australia. Climatic change identified by morphology substantiates the relevance of the climatic concept. Though uniformitarianism is widely accepted as governing the formation and destruction of landforms by processes in the past similar to those operating today, catastrophic events are not completely ruled out. The latter can bring about a change in a day's time, which may take hundreds of years in some cases. Examples of these can be met with in high, glaciated mountainous regions and along some coasts. King was not unaware of these though.

The author ably sums up the review under the title "Derived General Statements". He accepts that King's

analysis and synthesis were bold and stimulating, but notes that some conclusions were far-fetched and needed scrutiny before acceptance. The generalisations and suggestions made by Twidale deserve attention of the future researchers in this field. Under 'Conclusions,'¹ the author explains the possible reasons for the failure of the 'canons,' from being accepted by all, but concludes that "although not achieving all that he had hoped, he is deserving praise."

Over a period of almost four decades, there have been substantial contributions published right from the Proceedings of the Seminar on "Geomorphic Studies in India" held in Sagar in 1965 to the Memoir on *Sahyadri* in 2001 (Geological Society of India, 47(1&2), 1054p) and beyond as well, on various types of studies in the field of geomorphology in the country. It is unfortunate that Twidale has totally ignored all the work from India in this context.

Some of them were earned out on the lines initiated by Lester King. In the earlier stages an attempt was made to correlate the palaeosurfaces recognised in peninsular India with those suggested by him in other parts of Gondwanaland. Later studies were, however, found to be indicating variations in this correlation. This was due to detailed mapping and understanding of the role of neotectonics, made possible by geophysical surveys and recognition of geomorphic indicators of neotectonics in different parts of the country. Pediments and pediplains were also recognised, based on reconnaissance surveys, but later detailed field studies indicated that some of them are not pediplains. In other words, it was realised that at least some of the 'canons' are not globally applicable.

It should be admitted that field and laboratory investigations on the study of processes operating, are few and far between in this country. This is where Twidale's analysis of such studies made elsewhere and his own inferences and contribution are valuable. These together with almost about 450 references, should be a wealth of information to a student of geomorphology in India.

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