THE SARASWATI WAS A MAJOR RIVER

by K S Valdiya

Before summarily dismissing the existence of the River Saraswati that nourished the Harappa Civilization for several thousand years, I wish the authors giving their conclusions on the basis of optically stimulated luminescence dating of aeolian sands (Sanjeev Gupta and Hideaki Maemoku cited by Lawler 2011), had taken note of the mass of critical data gathered by geologists, geomorphologists, geohydrologists, remote-sensing experts and archaeologists. The data painstakingly collected over several decades by specialists in tectonics, sedimentology, palynology, geochronology, remote sensing and archaeology were the basis of the reconstruction of the history of the River Saraswati.

(1) The more than 2000 settlements of the people who lived in a style, had artistic appreciation and elegant tastes, had built sound brick-houses in towns with well-laid streets and lanes with drainage system, dug brick-lined wells to tap groundwater, harvested cereal crops on the flood plains, used scientific system of weight measurement, copper and bronze tools, and artistically engraved seals for trading (Joshi and Bisht,1994; Lal, 2002), testify to the incontrovertible fact that it was a land endowed with abundance of riverine water and greenary. The population of India then was very small and the country was blessed with vast stretches of fertile and adequately watered lands. Why should then the affluent, vibrant and progressive people choose to live for several thousand years in the Saraswati domain if it was not well-watered by a big river ?

(2) The Aravali orogenic belt is riddled with a multiplicity of long and deep faults, most of them parallelling the trend of the mountain, and some transverse to it and extending across the Saraswati domain. The tectonically resurgent Aravali and the land beyond stretching to the far west have witnessed strong seismotectonic upheavals many a time in the late Quaternary time (Bakliwal and Ramasamy, 1987; Sinha-Roy et al., 1998; Valdiya, 1998, 2002, 2010; Bakliwal and Wadhwan, 2003). The faults have been and continue to be active, registering strike-slip (sideway),

dip-slip (up-and-down) and both lateral left-right and up-down movements time in and time again. As a consequence, there was uplift and sinking or horizontal (lateral) displacement of the ground. Under such tectono-physiographic upheavals, the rivers and streams were frequently forced to change their courses, sometimes gradually, sometimes abruptly, as seen spectacularly in the land of the Saraswati. The Saraswati and its tributary rivers shifted progressively westward as the Aravali rose up. Sometimes they moved eastward following the sinking of the land in the east due to faulting-down movement. The existence of a multiplicity of palaeochannels that remote-sensing studies, applying such methodology as pyramidal tracing process on high-resolution satellite pictures and radar imagery (Ramasamy et al., 1991; Kar, 1999; Sahai, 1999; Nair et al., 1999; Rajawat, 1999; Gupta et al., 2004, 2008) unambiguously demonstrate westward and eastward shifting of the River Saraswati all through its reach in Haryana, northwestern Rajasthan of eastern Sindh.

(3) The enormous volume of fluvial-alluvial sediments, borne out by the great areal extent and thickness (5 to 30 m, locally as much as 90 m) of the Saraswati domain (Singhvi and Kar, 1992; Courty, 1995; Raghav, 1999) demonstrates unequivocally that the river that deposited them must have been a great river, bringing sediments even from as far as the inner Himalaya (Courty, 1995: Puri et al., 1998: Puri, 2008). Later (after 3900 to 3700 yr BP) this great river degenerated into a petty rivulet characterized by ponding and development of marshes, and finally disappeared owing to the diversion of its two main Himalayan-born branches resulting from very strong tectonic activities (Valdiya, 2002, 2008). The abandoned channels of the frequently shifting river now lie buried deep under the voluminous pile of aeolian sands and silts of the Thar Desert characterized by a variety of dunes.

(4) The Ghagghar, the present name the middle reaches of the Saraswati, is 6 to 8 km wide at Shatrana (25 km south of Patiala) and more than and 10 km wide near Anupgarh in northwestern Rajasthan. The average width is 3 km. It is quite evident that the

river which was 3 km wide on the average must have had voluminous discharge, implying that it was a great river.

(5) The large number of the buried channels of the Saraswati still contain sweet water as old as 22,000 to 6000 yr BP in the 60 – 250 m deep aquifer and 5000 to 1800 yr BP at the depth of 30 – 50 m below surface in the Jaisalmer district (Nair et al., 1999) and 12,900 to 4700 y BP in Cholistan (in the Hakra reach of the Saraswati) (Geyh and Ploethner 1995). Near Jaisalmer a palaeochannel at the depth of 450 – 500 m has yielded 40,000 year old sweet water, and in the acquifer shallower than 200 m the water is 17,000 to 9000 year old (Reddy et al., 2011). Interestingly, in the vast realm of brackish groundwater the discharge of the paleochannel-derived fossil water is showing no sign of decline despite over-exploitation. Very significantly, the absence or near absence of tritium in the fossil water shows that it is not the rainwater that percolated down to these depths. Where did this water come from if it was not a perennial river with multiple ramification?

Thermoluminescence dating of the sands and the carbonate concretions in the Thar Desert suggests that the hot dry conditions prevailed since at least 2,00,000 yr BP (Singhvi and Kar, 1992; Dhir et al., 1999). The prolonged period of dryness was broken by several spells of heavy rainfall — 40,000 to 20,000 yr BP, 9500 to 6500 yr BP and 2600 to 2000 yr BP (Singhvi and Kale, 2009). The testimony of spores and pollens of such plants as *Pinus, Astemesia* and *Syzygium* recovered from the lakes Lunkaransar and Didwana demonstrates heavy rainfall in the period 8500 to 4000 yr BP (Singh et al., 1974; Bryson and Swain, 1981). Recent high resolution oxygen-isotope dating of the material from the Lunkaransar Lake shows that the rainfall was of the order of 65 to 100 cm/yr and that the lake was filled to the brim in the period 6300 to 4800 yr BP (Enzel et al., 1999) — the period when the Harappa Civilization was in its mature stage If one considers the long intervals of heavy to very heavy rainfall in the context of the large width (average 3 km) of the Saraswati one cannot but conclude that the Saraswati was a big river during the Mature Harappa time.

It should also be appreciated that the wise people that the Harappans were, they would not have built their houses on the banks of the *channel* of the river prone to recurrent floods. The settlements were presumably located away from the channel — on the limits of the *floodways*. A floodway is that part of the river valley which experiences at least one-foot inundation by floodwater at least once in a period of one hundred years. In other words, the floodway conveys the highest flood discharge at least once in a hundred-year period. That explains why there are no tell-tale evidence of flood damage in the Harappan settlements.

(6) The thermoluminescence dating of sands and calcareous concretions in the aeolian sediments of the Thar also shows that in between the predominant semi-arid conditions, there were intervals of intense aridity when hot dry winds blew in cyclic fashion — 14,000 to 10,0000 yr BP, 5000 to 3500 yr, 2000 yr BP, 800 to 600 yr BP (Shnghvi and Kar, 1992; Dhir et al., 1994). The fierce desert winds scraped, eroded, sifted silts and fine sands and transported them long distance — building dunes, filling and burying floodways and channels in some places and unearthing older channels elsewhere. The desert winds thus brought about profound changes in the landscape time in and time again.

If one takes into consideration the above–mentioned facts and reads the history of the River Saraswati domain in its totality, one can understand why the drilled cores yielded the OSL dates of 14,000 BCL and 10,000 BCE (S. Gupta and H. Maemoku cited by Lawler, 2011) in the Ghagghar –Hakra reaches of the Saraswati. I believe they have not dated the in situ fluvial sediments, or possibly they were not on the beds of the channel of the Saraswati that supported and nourished the Harappan Civilization and hence concluded that "there was no big river here" and "No, it wasn't mighty" (in Lawler, 2011).

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References

Bryson, R. A. and Swain, A.M., 1981. Holocene variations of monsoon rainfall in Rajasthan, *Quat. Research*, 16, 135-145.

Bakliwal, P. C. and Wadhwan, S.K., 2003. Geological evolution of Thar Desert in India — Issues and prospects, *Proc. Indian Nat. Sci Acad*., 69A, 151-165.

Bakliwal, P.C. and Ramasamy, S.M. 1987. Lineament fabric of Rajasthan and Gujarat. *Record Geol. Survey Ind*., 113, 54-65.

Courty, M.A., 1995. Late Quaternary environmental change and natural constraints to ancient landuse (Northwest India). In : Johnson, E (Ed) *Ancient Peoples and Landscapes*, Museum of Texas University, Lubbok Texas, 106-126.

Dhir, R. P. Rajaguru, S. N. and Singhvi, A. K., 1994. Desert Quaternary formations and their morphostratigraphy : Implications for the evolutionary history of the Thar, *Jour. Geol. Soc. India*, 43, 435-447.

Geyh, M.A. and Ploethner, D., 1995. An applied palaeohydeological study of Cholistan, Thar Desert, Pakistan, In : Adar, E.M. and Leibundgut, C. (Ed) *Applications of Tracers in Arid Zone Hydrology*, Internat. Assoc. Hydrological Sciences, Vienna, 119-127.

Enzel, Y. Ely, Mishra, L.L., Ramesh, S., Amit, R., Lazar, B., Rajaguru, S.N., Baker, V.R. and Sandler, A., 1999. High resolution Holocene environmental changes in the Thar Desert, NW India, *Science*, 284, 125-128.

Gupta, A.K., Sharma, J.R., Sreenivasan, G. and Srivastava, K. S., 2004. New findings on the course of river Saraswati, *Photonirvachak*, 32, 1-24.

Gupta, A.K., Bhadra, B. K. and Sharma, J.R., 2008. Saraswati drainage system of Haryana — satellite based study. In : S. Kalyanaraman (Ed.) *Vedic Saraswati and Hindu Civilization,* Aryan Books International, New Delhi, 46-64.

Joshi, J.P. and Bisht, R. S., 1994. *India and the Indus Civilization*, National Museum Institute, New Delhi.

Kar, Amal, 1999. A hitherto unknown palaeodrainage system from

the radar imagery of southeastern Thar Desert and its significance, *Memoir Geol. Soc. India*, 42, 229-235.
Lal, B.B., *The Saraswati Flows On*. Aryan Books International, New Delhi, 148 p.
Lawler, Andrew, 2011. In Indus times, the River didn't run through it, *Science*, 332, p 23.
Nair, A.R., Navada, S.V. and Rao, S.M., 1999. Isotope study to investigate the origin and age of groundwater along palaeochannels in Jaisalmer and Ganganagar districts of Rajasthan, *Memoir Geol. Soc. India*. 42, 315-319.
Puri, V.M.K. and Verma, B.C., 1998. Glaciological and geological source of Vedic Saraswati in the Himalayas, *Itihas Darpan*, 4, 7-36.
Puri, V.M.K., 2008. Vedic Saraswati : Scientific signatures on its origin from Himalaya. In : Kalyanaraman, S. (Ed.) *Vedic Saraswati and Hindu Civilization*, Aryan Books International, New Delhi, 14-15.
Raghav, K.S., 1999. Evolution of drainage basins in parts of northern and western Rajasthan, Thar Desert, India, *Memoir Geol. Soc. India*, 42, 175-185.
Rajawat, A.S., Sastry, C.V.S. and Narain, A., 1999. Application of pyramidal tracing process on high resolution I.R.S.-1.-C data for tracing migration of the Saraswati River in parts of the Thar Desert. *Memoir Geol. Soc. India*, 42, 259-272.
Ramasamy, S.M., Bakliwal, P.C. and Verma, B.P., 1991. Remote sensing and river migration in western India, *Intern. Jour. Remote Sensing*, 12, 2397-2609.
Reddy, D.V., Nagabhushanam, P. Rao, M.R. and 4 others 2011. Radiocarbon evidence of palaeorecharge (pre-Saraswati period) of potential deep aquifers in the Thar Desert, *Jour. Geol. Soc. India*, 77, 239-242.
Sahai, Baldev, 1999. Unravelling of the lost Vedic Saraswati, *Memoir Geol. Soc. India*, 42, 121-141.
Singh, G., Joshi, R.D., Chopra, S. K. and Singh, A. B., 1974. Late Quaternary history of vegetation and climate of the Rajasthan desert India, *Philos. Trans. Royal Society*, *London*, 267B, 467-501.

Shighvi, A. K. and Kar, Amal, (Ed) 1992. *Thar Desert in Rajasthan : Land, Man and Environment,* Geol. Society India, Bangalore, 186p.

Shighvi, A. K. and Kale, V. S., 2009. *Palaeoclimate Studies in India* : *Late Ice Age to Present*, Indian National Science Academy, New Delhi, 34p.

Sinha-Roy, S., Malhotra, G. and Mohanty, M., 1998. *Geology of Rajasthan*, Geol. Soc. India, Bangalore, 278 p.

Soni, V., Sharma, D.C., Srivastava, K.S., Sisodia, M.S., 1999. Hydrological geophysical and isotope study to trace the course of the buried Saraswati River in Jaisalmer district, Rajasthan, In : Paliwal, B. S. (Ed.) *Geological Evolution of Northwestern India,* Scientific Publishers, Jodhpur, 305-311.

Valdiya, K. S. 1996. Saraswati that disappeared. *Resonance*, 1(5), 19-28.

Valdiya, K. S., 2002. *Saraswati: The River That Disappeared*, Universities Press, Hyderabad, 116p.

Valdiya, K. S., 2010. *The Making of India : Geodynamic Evolution*, Macmillan, NOIDA, 816p., Chapter 23, 549-561.