

Populus euphratica in Niya site
~Scientific assessment of deterioration and aspects in humane studies~

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Niya site is located near the center of the Silk Road in the district of Minfeng lying in the Xinjiang Uighur Autonomous Region of the People's Republic of China. The southern half of the region is the vast Tarim basin, which spreads for 550 km from north to south and as much as 1000 km from east to west, mainly constituted by the Taklimakan Desert so called "Sea of Death". Set 100 km from Minfeng at the southern tip of the Taklimakan, Niya is believed to have flourished from the 1st century BC to the 4th century AD, and has been identified as the Jingjue Kingdom referred to in the Han Book. Occupying an extensive area of approximately 25 km from north to south and 7 km from east to west, the Site comprises about 100 ruins of dwellings, garden, agricultural fields and a huge number of dead trees. Niya site is praised as the "Pompeii of the Silk Road" because of its great historical importance buried under ground and kept remained. The extraordinary archeological excavation of Niya site and carbon 14 dating made it clear that housing pillars still standing after 2000 years and almost all of the trees were *Populus euphratica* Olivier (koyo). Because of its strong salt tolerance, koyo is used as a afforestation tree for Taklimakan desert today.

Koyo excavated from Niya site have been exposed to the ultraviolet rays of the sun, strong wind and dry climate for 2000 years. Therefore the surface of wood samples are discolored to almost white. In addition a series of many cracks along the longitudinal direction are obvious. Among our collection, samples from 3 kinds of eras (190, 1558~1667, 1900~2354 years-old) are subjected to physiochemical analysis. As a standard material, a present Koyo from China was used for comparison.

The samples examined were all anatomically identical with present koyo wood from China. However, there found considerable differences in physical properties, such as Young's moduli, loss tangent ($\tan\delta$). Particularly, in the static three-point bending test, Niya samples were much inferior in terms of fracture toughness, which strongly suggests that the sample became fragile by aging. This was also corroborated by the straight fracture line and the flat fracture surface of the Niya wood.

As mentioned above, the surface of the Niya wood were all discolored, probably due to degradation of lignin components by the ultraviolet irradiation. However, no significant spectroscopic differences in functional groups of carbohydrate regions were not detected, when a few millimeters from the surface was analyzed. Therefore, the major factor of deterioration in Niya wood was considered to be "thermal", more than UV and biological deterioration.

Such features of deterioration are quite similar to those reported for aged wood from the traditional Japanese constructions, where the deterioration "aging" is said to be caused by oxidation, i.e. thermal process.