

The resistivity data measured in the field were then treated and plotted as resistivity cross sections of different pseudo-depths, showing the specific influence of the different targets laying at the corresponding depths. The procedure, even though more time consuming, looks as a very promising technique for discovering near-surface targets through resistivity survey, reflecting successively the resistivity variations with depth, and

separating anomalies in regard to their depth situation below the surface within the first ten meters. It offers also higher reliability of results, due to confirmed response of the subsurface targets noticed as multiple anomaly on several cross sections with gradually growing depths. Many of these anomalies measured along the resistivity profiles were verified through excavation work.

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Assignment of Mummies in Chusonji Temple to Fujiwara Chieftains with the Aid of NMR for Silks in These Coffins

Chusonji is the buddhist temple constructed in the 12th century at Hiraizumi city, Northeast Japan. In this temple three mummies are still preserved: they are

- Kiyohira Fujiwara (died in 1128)
- Motohira Fujiwara (died in 1157)
- Hidehira Fujiwara (died in 1187)

All of them were Fujiwara chieftains. In the coffins of these mummies many silk materials were used.

The amino acid composition may be determined from ¹³C NMR (Nuclear Magnetic Resonance) for these silk materials. Due to the degumming of the materials they are not dissolved into any solvent. Only solid state NMR can be applicable. Solid state one is insufficient in the resolution compared with solution one. In Figure 1 are shown typical spectra. Chemical shift splittings are observed in C=O region between Gly and Ala. The mole fraction of these two amino acids are different with each other.

Possible candidate of the origin of such difference in the fraction is climate (especially temperature) when silkworm was reared. Actually, from the comparison with dendrochronological data good correlation was obtained. However, the number of samples is confined to only three. In order to overcome the insufficiency of number of the samples we have to introduce an alternative strategy. It is NMR observation of modern silk reared in definite temperatures. In this case we can use solution state NMR to silk gland extracted from silkworms. Chemical splittings were observed in C α region due to good resolution and the mole fraction was able to determine for Gly, Ala, Ser and Val. Three species were used as follows:

- Shunrei No. 1 x Shogetsu No. 1: the most popular since Mendel's law.
- Habataki: special species which can feed on apple as well as mulberry.
- Koishimaru: the oldest species existing at present.

Temperature dependence was clearly observed for all species. Qualitative coincidence can be confirmed between the fraction of above and this NMR data. Only the numerical values for Habataki cover those for silks in the coffins. From the comparison between them temperature was estimated as follows:

- 1128: 27.1 °C
- 1157: 26.2 °C
- 1187: 27.5 °C

According to the document (established in the 14th century) of the sutra stock house of Chusonji, in the central, the left and the right coffins Kiyohira (the first), Motohira (second) and Hidehira (third) were preserved, respectively. This document is thought to be reliable. However, there is still one unsolved problem. There are two ways on the definition between left and right. In Japan the definition was usually done from the respected persons side. The respected person means buddha image in this case. This is a completely opposite definition from that of prayers side. From the NMR investigation in this study the definition from the respected person side is supported. The definition has to go back to the former one at least from this study. This conclusion is reasonable from the standpoint of Japanese traditional definition between left and right.

Fig. 1. Solid state ¹³C NMR spectra of silk materials preserved in the coffins in Chusonji temple

