Differences of Petroglyph Styles among Archaeological Sites with Spatial and Time-wise Distances

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Differences of styles of petroglyphs among several archaeological sites in the Central Asia are estimated based on the method of obtaining shape codes of petroglyphs, which was developed by the present authors. The samples for shape code analysis are confined to the petroglyphs of ibex (wild goat), which were abundantly carved in the Central Asia. It is shown that the style differences are correlated to the mutual distances among archaeological sites, but not to the differences of ages among them. This result supports the common opinion of archaeologists that petroglyph styles have not changed much since the Stone Age. This result is discussed from cultural aspects.
Key words: Petroglyph, Central Asia, Image Analysis, Skeleton, Style Difference

1. Introduction

In some regions in Central Asia and Russia a lot of petroglyphs of animals, humans and celestial bodeis are conserved, which were carved on rock surfaces from the Stone Age to several centuries A.D.. These petroglyphs are introduced in several references (Sher, 1980; Lasota-Moskalewska and Khujanazarov, 2000; Tashbayeva *et al.*, 2001). The present authors proposed a new quantitative method to characterize shapes of petroglyphs based on image analysis (Takaki *et al.*, 2006), and presented it at some conferences (Takaki *et al.*, 2009, 2010). The motivation of this work was an archaeologists' question why petroglyph styles did not change much for tens of thousands of years. For this question the present authors considered a necessity of a quantitaive method to cahracterize their styles. In this study figures of petroglyphs of ibexes (wild goats) were chosen because they are abundantly produced in Central Asia (see Fig. 1), and their image data are taken from Tashbayeva *et al.* (2001). A brief explanation of this method is given in the next section (the precise is given in Takaki *et al.*, 2006).

2. Method of Analysis

From a digitized silhouette data of petroglyph a line figure called "skeleton" is obtained, which is a trajectory of centers of contact circles (see Fig. 2(a)), where a software 'Scion Image' is used in this process (at present a new version of this software "ImageJ" is available). Skeletons of ibexes are composed of parts easily recognized by naked eyes, that is, a nose (front tip of body), one or two horns, a neck, one or two fore-legs, a center of body, one or two rear-legs and a tail. They were given symbols, 'N, H, N, L, B, L, T', respectively, and these symbols are arranged in order
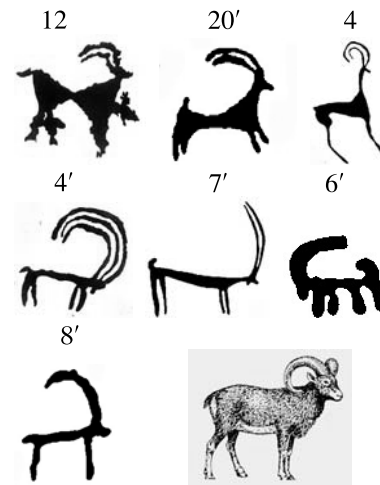

Fig. 1.   Examples of ibex figures from seven archaeological sites (from Tashbayeva *et al.*, 2001) and a sketch of ibex (from Lasota-Moskalewska and Khujanazarov, 2000). Numbers correspond to those in Fig. 4.

from the nose through the tail as 'N-HH-N-LL-B-LL-T', where doubled symbols indicate the numbers of respective parts. Then, the difference in shapes is expressed as that of arrays of these symbols.

Since this array of symbols is not precise enough to distinguish various shapes, we observe fine structures of skeletons, as listed below:

- If a single line (a horn or a leg) comes out and branches into two, a symbol 'HH' or 'LL' is replaced by 'HB' or 'LB' ('B' means "branch").
- If two horns or legs are connected by lines after com-