

# THE DISCOVERY OF STONE IMPLEMENTS IN THE GRENZBANK: NEW INSIGHTS INTO THE CHRONOLOGY OF THE SANGIRAN FLAKE INDUSTRY

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## ABSTRACT

*The chronology of the Sangiran artefacts has been debated for more than 50 years since the discovery of the so-called Sangiran flake industry by von Koenigswald at Ngebung in 1934. Many researchers have been trying to determine the most reasonable chronology for the Sangiran artefacts. During our last two years of excavation at Dayu (Sangiran), we found the Sangiran flake industry in the Grenzbank between the Kabuh and Pucangan layers. It consists of flakes, scrapers, and borers made from chalcedony and silicified tuff. These stone implements are certainly the oldest artefacts ever found at Sangiran, dating back to at least 800,000 years ago.*

## THE PROBLEM OF THE AGE OF THE SANGIRAN ARTEFACTS

The problem of the age of the flake implements found by G.H.R. von Koenigswald at Ngebung (Sangiran) in 1934 – later known as the Sangiran flake industry (von Koenigswald 1936; von Koenigswald and Ghosh 1972) – has remained unsolved for over half a century and has become the subject of long discussions. When first discovered, the finds were scattered on the surface of gravels, exposed by the erosion of the hills in the northwest of the Sangiran dome. Von Koenigswald (1936) correlated these finds with the upper layers of the Kabuh Series of the late Middle Pleistocene, since they were associated with the remains of Trinil fauna. His conclusion aroused much criticism.

In their observations of the stratigraphical position of the Sangiran flake industry, Helmut de Terra, Hallam L. Movius and Teilhard de Chardin, from the Joint American-Southeast Asiatic Expedition for Early Man, assumed that the artefacts originated from the gravel of the Notopuro

Series (de Terra 1943), which lies unconformably on the tuffs of the Kabuh Series. They stated that no artefacts could be found below the gravel of the Notopuro Series, and interpreted the Sangiran flake industry as too advanced for the Sangiran *Pithecanthropus* (*Homo erectus*).

This interpretation of a younger age than that favoured by von Koenigswald has been supported by R.W. van Bemmelen (1949) and G.J. Bartstra (1985). According to these authors, the Trinil fauna is mixed with Sangiran artefacts on the surface at Ngebung in a situation of secondary deposition. Since this gravel layer does not contain the Trinil fauna in its *in situ* location, there is no reason to correlate the Sangiran artefacts with the hominids of the Middle Pleistocene. It was subsequently noted that rounded Sangiran flakes were mixed with flakes of a younger date, a result of fluvial transportation (Bartstra 1985; Bartstra and Basoeki 1989). The gravel layer is assumed to have been deposited after the folding of the Sangiran Dome, at the time when the Cemoro, Brangkal and Pohjar rivers started to downcut into the dome. Bartstra (1985) and Bartstra and Basoeki (1989) have suggested that the Ngebung artefacts date to the first half of the Late Pleistocene.

## STRATIGRAPHIC POSITIONS OF THE SANGIRAN ARTEFACTS

The result of our recent research at Sangiran, which was intensively conducted from 1994 to 1998, shows that the Sangiran flake industry is not only found at Ngebung, but on all surfaces of the Sangiran Dome (Widiyanto *et al.* 1996; Widiyanto *et al.* 1997). The main distributions are found in the north, in the east and in the south, and lie on terrain of the Kabuh and Notopuro Series. Moreover, the northern part of the Sangiran Dome has yielded more than 125 massive tools made from andesitic and basaltic rock. These tools are found along the channels of the Kali Kedungdowo, Kali

Brangkal, Kali Teseh, Kali Bulurejo and Kali Jatibatur, all of which incise the andesitic laharic breccia layer and the fluvio-volcanic sand of the Notopuro Series. Most of the artefacts, especially those from the Kali Kedungdowo, were found in the laharic andesitic breccia layer with fragments of angular igneous rock up to boulder size, indicating that they were incorporated into the Notopuro lahar.

The typology of these massive tools from Sangiran conforms to that of the Pacitanian culture (the chopper-chopping tool complex), with the main types being choppers, chopping-tools, hand axes and hand adzes. There are also polyhedric tools and hammerstones (Widianto *et al.* 1997). The existence of these massive tools – formerly thought to be absent in the assemblages of the Sangiran industry – is clearly proven by the new data, and now it appears that they can be correlated with the andesitic laharic breccia of the Notopuro Series (Widianto *et al.* 1997).

#### STRATIGRAPHIC POSITION OF THE SANGIRAN FLAKE INDUSTRY

The assemblages of non-massive tools (flakes, blades, and scrapers) come from three stratigraphic horizons. These are the terraces of the Kabuh Series at Sendangbusik, Dayu, Sendangduren and Brangkal; the terraces of the Notopuro Series at Tapan, Kedungulo and Karangnongko; and the block-landslide of the Kabuh Series at Ngledok, situated about 300 m to the south of the present Sangiran Museum. These horizons are very significant in interpreting the stratigraphic position of the Sangiran flake industry.

Based on a survey of the terraces and examination of lithological columns at 17 locations in the Sangiran Dome, we have identified three main terrace elevations. These are at 3–8 m elevation above the present river level, at 9–22 m and over 22 m (Widianto *et al.* 1996). The majority of artefacts are found in the lowest and youngest terrace complex at 3–8 m, for example, at Dayu, Sendangbusik, Sendangduren and Karangnongko. This suggests that these artefacts derived originally from the Kabuh Series before they were deposited in the terrace system. This interpretation is based on the reasoning that the oldest terrace (at an elevation of over 18 m) is formed by the erosion of the young lithology of the Notopuro Series, because the river system – responsible for the formation of the terraces at Sangiran – began only in the period after the Notopuro Series was formed.

On the contrary, the material of the younger terraces – for example, on the 3 m and 6–8 m elevations which are known to contain the majority of artefacts – was formed by erosion that is theoretically older than the Notopuro Series, when the global erosion at Sangiran had already reached the fluvio-volcanic sand of the Kabuh Series. The succession of terraces indicates also the succession of the erosion: the

erosion of an older lithology in one stratigraphical system will be re-sedimented into a younger terrace. This interpretation applies to all the existing terraces, in the sense that the elevation of terraces becomes the main aspect to be considered for the understanding of the correlation between the artefacts and the artefact bearing-layer. Therefore, it is interpreted that the artefacts found in the lower terraces at Sangiran derive from the erosion of the Kabuh Series and were subsequently redeposited in terraces in several parts of the Sangiran Dome after the formation of the Notopuro Series. This is supported by the absence of artefacts on the higher terraces over 18 m, as at Brangkal.

At Ngledok, we can observe stratigraphical units, from the base upwards, consisting of the black clay of the Pucangan Series (in the slopes and the river bed of the Kali Cemoro), the Grenzbank, the fluvio-volcanic sand of the Kabuh Series, and the laharic breccias and fluvio-volcanic sand of the Notopuro Series (Figure 1). More detailed observation of the Sangiran flake industry here indicates that the artefacts derive stratigraphically from the very lowest part of the Kabuh Series, which is a conglomerate gravel layer of a channel-lag deposit. The surrounding area is dominated by the black clay of the Pucangan Series, and in several places, within a distance of only tens of metres, the Grenzbank layer is exposed, still *in situ* in its original position. During the survey, we found a scraper directly associated with the Grenzbank deposit. To determine the stratigraphical position of these artefacts more precisely, we carried out an excavation of this channel-lag deposit.

The excavation – measuring 2 x 1 m – reached a depth of 4.70 m, extending down to the Grenzbank. This excavation confirms that the channel-lag deposits in the lowest part of the Kabuh Series lie above and in direct contact with the Grenzbank, implying that they were formed at the very beginning of the Kabuh Series itself.

A total of 51 artefacts and 232 pieces of raw material ranging from gravel to pebble size were found during the excavation of the channel-lag deposit at Ngledok. These finds are spread vertically, with the greatest accumulations at depths of 0.70–1.90 m and 2.90–3.80 m. The lowest flake was found at a depth of 4.60 m, only 10 cm above the Grenzbank. One most important point to be noted here is the continuous distribution of the artefacts from the surface of the excavation square down to the basal gravel layer, immediately above the Grenzbank.

Excavations were also conducted in the terrace of Dayu, which is cut into the lower part of the Kabuh Series. The excavation penetrated the terrace itself, the lower part of the Kabuh Series, the Grenzbank, and the upper part of the Pucangan Series (Figure 2). The results were quite spectacular: we found 27 non-massive tools *in situ* in the

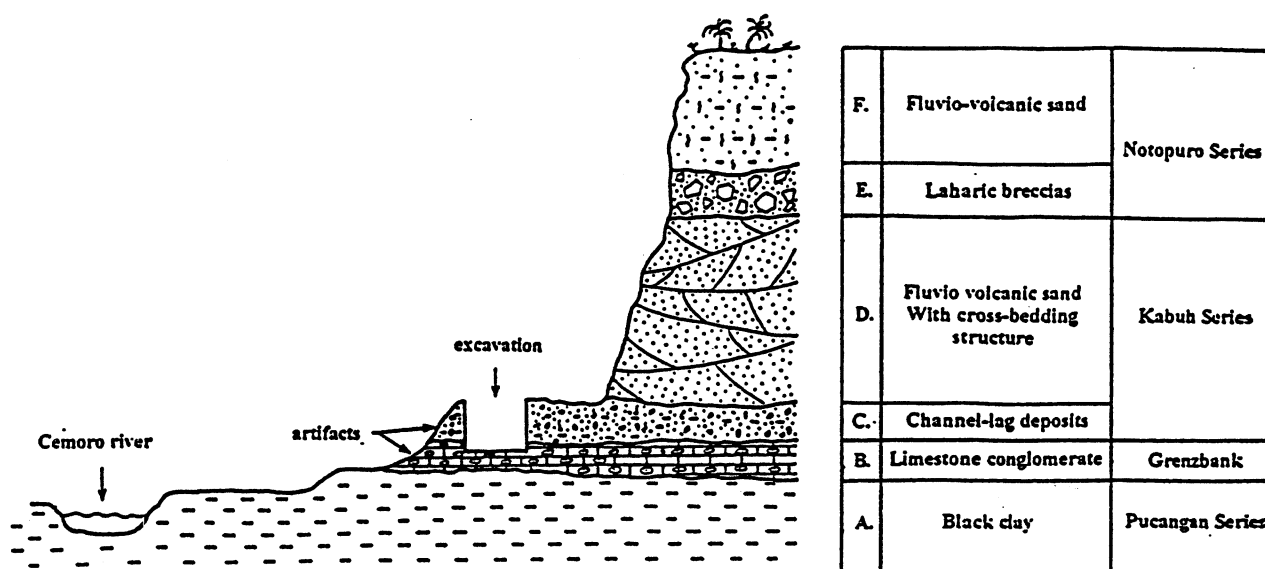


Figure 1: The stratigraphic position of the Sangiran Flake Industry at Ngledok:

F. Fluvio volcanic sand. whitish brown clay to coarse sand, gravel, lag deposits, andesite fragments, compact, part of the Notopuro Series.

E. Laharic breccias, andesite fragments up to boulder size, volcanic sandstone matrix, part of the Notopuro Series.

D. Fluvio-volcanic sand, fine to coarse grain, clastic tuffaceous clay, quartz, cross-bedding, part of the Kabuh Series.

C. Channel lag deposits, conglomerate sandstone, with fragments of chalcedony, jasper, silicified limestone, quartz, clastical clay cemented by iron, containing the Sangiran flake industry, part of the Kabuh Series.

B. Conglomerate limestones, pisoid fragments, cemented in blackish sparite, containing the Sangiran Flake Industry, the Grenzbank.

A. Black clay, limestone concretions, mollusc fragments, upper part of the Pucangan Series.

Grenzbank, including 24 stone implements (flakes, scrapers and borers made from yellow chalcedony, jasper and silicified limestone) and three bone tools of scraper, borer and spatula type. This is the first discovery of the Sangiran flake industry actually *in situ* in the Grenzbank itself, and these are certainly the oldest stone implements ever found at Sangiran.

The lithology of the Grenzbank at Dayu is characterized by a dark brown to blackish brown limestone conglomerate, formed mainly of igneous materials and rather rounded fragments of pisoids measuring up to 0.5 cm, with fragments of fossil fauna, artefacts and a few quartz minerals, cemented by sparite. This conglomerate lies on the black clay of the Pucangan Series, below the cross-bedded sands of the Kabuh Series.

The excavation at Dayu attained more importance when we found a flake – directly associated with the fresh and hard Grenzbank – during a survey of the surrounding area, about 15 m from the excavation site. This flake was recovered from a 20 x 20 cm square in the Grenzbank deposit and is indisputable evidence that artefacts have been present at

Sangiran since the formation of the Grenzbank at the Early-Middle Pleistocene boundary.

Thus, the excavations at Ngledok and Dayu have proven to us that the Sangiran flake industry existed from the time of Grenzbank formation and continued into the lower part of the Kabuh Series. The industry has also been found at several localities dominated by the fluvio-volcanic sands of the Notopuro Series, at Ngleblak (Pungsari), Kricikan (Rejosari), Kedungboyo (Wonosari), Sendang-busik, and at Ngrawan. The lithology of these localities is very different from the Kabuh Series. Surveys at Padas have resulted in the discovery of a yellow chalcedony backed scraper, directly associated with a fallen boulder of gravel conglomerate from the Notopuro Series. Indeed, most of the non-massive tools in the terrace deposits of the Notopuro Series derive from the erosion of the Notopuro Series itself. Thus the Sangiran flake industry perhaps continued in existence through the entire Kabuh and Notopuro Series.

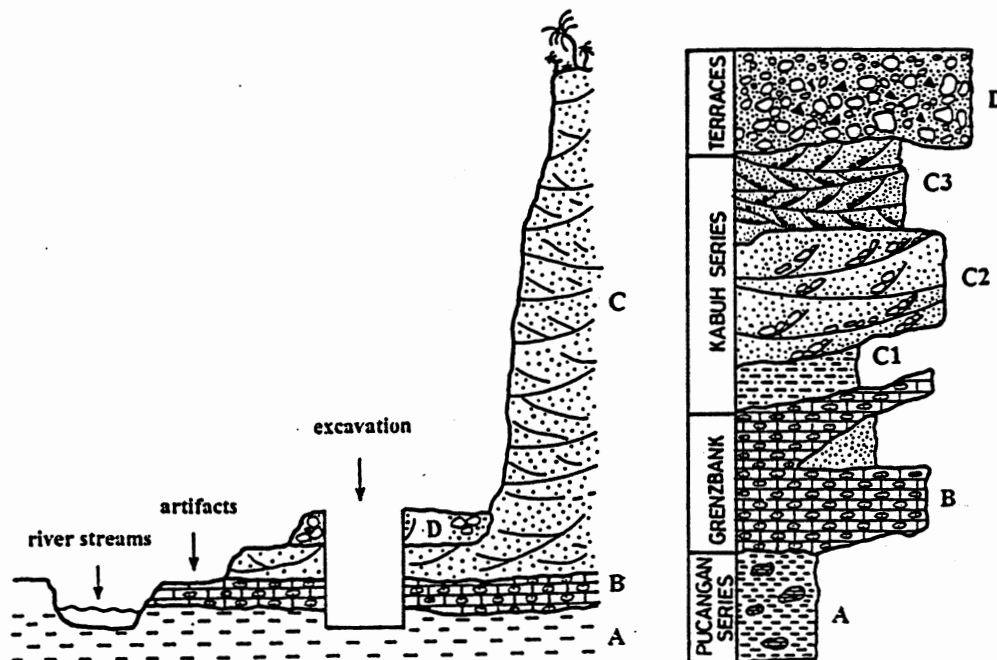


Figure 2: The Stratigraphical Position of the Sangiran Flake Industry at Dayu:

D. Terrace conglomerate, blackish brown (coarse sand to gravel, andesite gravel fragments up to boulder size, rounded, containing massive and non-massive tools.

C3. Fluvio-volcanic sand, cross-bedded structure, yellowish brown, good sorting, part of Kabuh Series.

C2. Conglomerate sand, cross-bedded structure, tabular, orientation of fragments not on the erosion platform, blackish brown, cemented by iron, part of Kabuh Series.

C1. Sandy clay, brownish yellow, part of Kabuh Series.

B. Conglomerate limestone, pisoid fragments, cemented by sparite, containing the Sangiran Flake Industry, the Grenzbank.

A. Black clay, limestone concretion, mollusc fragments, upper part of Pucangan Series.

#### STRATIGRAPHIC POSITION OF THE MASSIVE TOOLS

The massive tools in the Sangiran Dome are always found within the context of the Notopuro Series, which at Sangiran consists of the following lithology. The lower part is dominated by laharic breccias with angular fragments of andesite, pebble to boulder sized, and a volcanic sand matrix. The upper part is fluvio-volcanic sandstone. The Notopuro Series lies unconformably on cross-bedded sandstones of the upper Kabuh Series. The source of the andesitic pebbles used to manufacture the massive tools is the laharic breccia layer, located in the lowest part of the Notopuro Series. This chronological placement is supported by the fact that surveys conducted on the terraces of the Kabuh Series (as at Dayu, Sendangbusik, Bapang, Tanjung, and Sendangduren) have shown the non-massive tools to be predominant in these contexts. But could the massive tools found at Ngebung have originated from the Kabuh layers? Both of the Ngebung tools were found on the surface of the Kabuh

Series, and this in itself helps to reinforce the probability of a Notopuro date. Chronological relationships as understood at present are illustrated in Figure 3.

#### THE DATING OF THE SANGIRAN ARTEFACTS

Absolute dates for the Grenzbank by the paleomagnetic method range from the early Brunhes at 0.73 mya (Sémah 1984) to the late Matuyama at 0.73-0.9 mya (Itiharta *et al.* 1985), with an average of 800,000 years. The upper part of the Notopuro Series dates to  $0.25 \pm 0.07$  mya, based on fission-track dating of a pumice sample of the fluvio-volcanic material (Itihara *et al.* 1985), or between 180,000 and 320,000 years ago. Thus, since the massive tools come from the laharic andesite breccia level in the lowest part of the Notopuro Series, they are certainly older than 180,000 years. In contrast, the Sangiran flake industry, with its very long vertical distribution spanning the sedimentation periods of the Grenzbank and the Kabuh and Notopuro Series, first

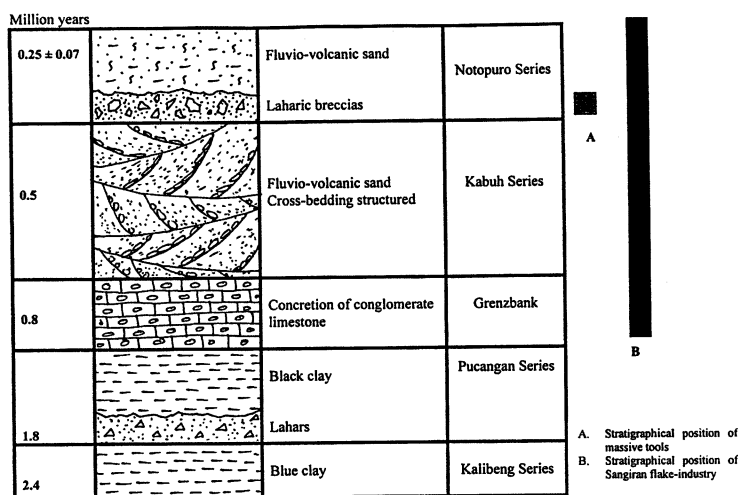


Figure 3: The stratigraphic positions and chronologies of Palaeolithic industries in Sangiran.

occurred at Sangiran 800,000 years ago, during the transition from the Early to the Middle Pleistocene. It is, therefore, much older than was assumed by von Koenigswald (1936, 1939; von Koenigswald and Ghosh 1972), de Terra (1943), Bartstra (1985) and Bartstra and Basoeki (1989). The results of our research show that the Sangiran flake industry is certainly representative of the artefacts of Sangiran *Homo erectus*.

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