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Short Note

New Discovery of Aira-Tn Ash(AT) in Korea

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아이라Tn화산재(AT)의 신발견

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Abstract : As a widespread tephra erupted 24 to 25 KA, Aira-Tn Ash, or AT, provides an invaluable datum for stratigraphic study of late Pleistocene in Northeast Asia. AT can be identified from their tonal characteristic and morphology (the so-called bubble-wall feature), as well as typical refractive index. First reported in 1983, its presence was confirmed from many palaeolithic deposits distributed throughout Korea. It forces us to reconsider the age of prominent Pleistocene deposits. At the famous archaeological site of Chon-gok-ni, presence of AT lends a firm support that sedimentation and deposition of lithic assemblage were in fact a late Upper Pleistocene event, thus, throwing a new question at archaeologists to explain why such archaic-looking tools were continued to be made. Discovery of AT at Chongdongjin is more surprising, since the coastal terrace has been regarded by many as an early Lower Pleistocene eustatic feature. It implies strongly that we need to devise a new scheme for Quaternary stratigraphy. In the absence of reliable datum and marker for Quaternary research, efforts must be given to search for and identify AT and other widespread tephras.

Key Words : AT, widespread tephra, late Pleistocene, Chon-gok-ni palaeolithic site, Chongdongjin coastal terrace locality

요약 : 24,000에서 25,000년 전 무렵 일본 구주의 아이라화산에서 분출한 아이라Tn화산재, 즉 AT는 동북아시아 플라이스토세 말의 중요한 층준이 되는 광역화산재이다. AT는 색상과 형태에 있어서의 특징, 특히 소위 bubble-wall구조라 불리는 형태적 특징에서 쉽게 확인할 수 있으며, 한국에서는 1983년 처음 발견되었다. 전국각지의 구석기퇴적층에 대한 조사 결과 모두 7 지점에서 AT를 발견할 수 있었다. 이러한 발견과 더불어, 몇몇 저명한 플라이스토세 퇴적층의 연대와 기원은 재고되어야 한다고 보인다. 널리 알려진 구석기유적인 전곡리에서의 AT 발견은 어째서 다른 지역에서는 이미 오래 전에 사라진 유물이 이곳에서는 플라이스토세 말기까지 계속 만들어졌는가 하는 새로운 질문을 던져 주고 있다. 또한, 동해안 정동진 남쪽 일대에 발달한 해안단구의 상부퇴적층에서도 AT가 발견되었다. 이곳의 해안단구는 플라이스토세 전기 초에 해수면변화로 형성된 지형이라고 여겨지고 있기 때문에 이러한 발견은 매우 충격적이라 할 만하다. 이러한 발견례들은 한반도 제4기 층서의 이해를 위한 새로운 틀이 필요하며 나아가 제4기와 관계된 여러 분야의 연구에서 광역화산재에 대한 고려가 필요함을 보여준다.

주요어 : 아이라 Tn 화산재, 광역화산재, 후기플라이스토세, 전곡리구석기유적, 정동진해안단구

1. Introduction

Volcanic ash is an extremely useful and important marker for stratigraphic correlation and/or age determination of deposits of varying context. This is especially the case when the fall-out from an eruption covers a large area. In northeast Asiatic context, there are known some number of

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such widespread isochronous tephras of late Quaternary age. Except those Holocene tephras erupted from Mt. Baekdu (白頭山) and Ulung Island (鬱陵島), the rest originated from volcanos in the Japanese archipelago which has a long history of active volcanism.

Among them is included the so-called AT, or the Aira Tanzawa Ash(始良Tn火山灰). Having originated from an eruption of the Aira caldera in the southwestern corner of Kyushu Island, Japan, it probably represents one of the better-studied tephras of the region. Today, the date of AT eruption is well fixed to ca. 24 to 25 KA(Machida and Arai 1976, 1992; Matsmoto *et al.*, 1987; Ikeda *et al.*, 1995). With its wide occurrence, AT has been extensively referred to for making temporal definitions and correlations of many late Pleistocene events across the archipelago. Probably its most greeedy beneficiaries are archaeologists, who casually and extensively relied upon its presence or absence to make area- and time-specific definitions of cultural episodes and sequences.

As one of the widespread tephras of the region, the occurrence of AT is of course not confined to Japan. Grains of AT volcanic glass are known from deposits as far west as the Shandong peninsula of China(Eden *et al.*, 1996). To the north, AT bearing deposit is reported from the Russian maritime region(Rajigaeva, 1993). Thus, the report of its discovery from Korea(Machida *et al.*, 1983) is not surprising at all, but so far no additional report of discovery has appeared. Such paucity of research seems to reflect that the value of AT, or in that sense any other widespread tephra, as a marker for late Quaternary research is yet to be fully appreciated.

2. Fieldwork and Procedure of Analysis

Discovery of AT by Machida and others(1983) was made at coastal localities in the southern part of Korea. However, data from neighboring areas suggest that AT should exist throughout much part of the Korean peninsula, and in essence it can be expected anywhere below the DMZ(Fig. 1).

In May of 1995, Yi and Soda first attempted to identify and define AT-bearing deposit in the Imjin River basin where many palaeolithic localities are known. Although the basin lies almost at the very limit of the zone of probable AT distribution, it is the area where efforts have been made somewhat systematically to obtain an overall picture of its Quaternary history(Yi, 1988; 1996).

In the Imjin basin, sampling for AT was made at two archaeological sites of Kawoli (佳月里) and Chon-gok-ni (全谷里) where good sectional profiles are readily available. The analysis confirmed the existence of AT glass shards within the deposit at both localities. Since that time on, quest for AT have been attempted at various palaeolithic localities throughout the country, where the age of deposits should be of late Pleistocene as hinted by the composition of lithic assemblage.

At the field, after stratigraphic profiles were observed and recorded, samples were taken from each stratigraphic unit at an appropriate interval. For most of the cases, the whole section was devided by 5cm intervals and samples were taken from each unit. When deposits are overwhelmingly thick, some units were excluded for sampling.

In the laboratory, samples were observed microscopically under polarized light to detect composition of volcanic glass and heavy mineral components. Most of the samples contain very limited amount of heavy minerals. Glass shards detected by microscopic examination were then submitted to measurement of refrative index to correlate to marker-tephras. The overall procedure of analysis can be summarized as follows:

a) 15 grams of sediment were taken out for each unit;
b) samples were cleaned by ultrasonic cleaner;
c) cleaned samples were dried at 80° Celsius in

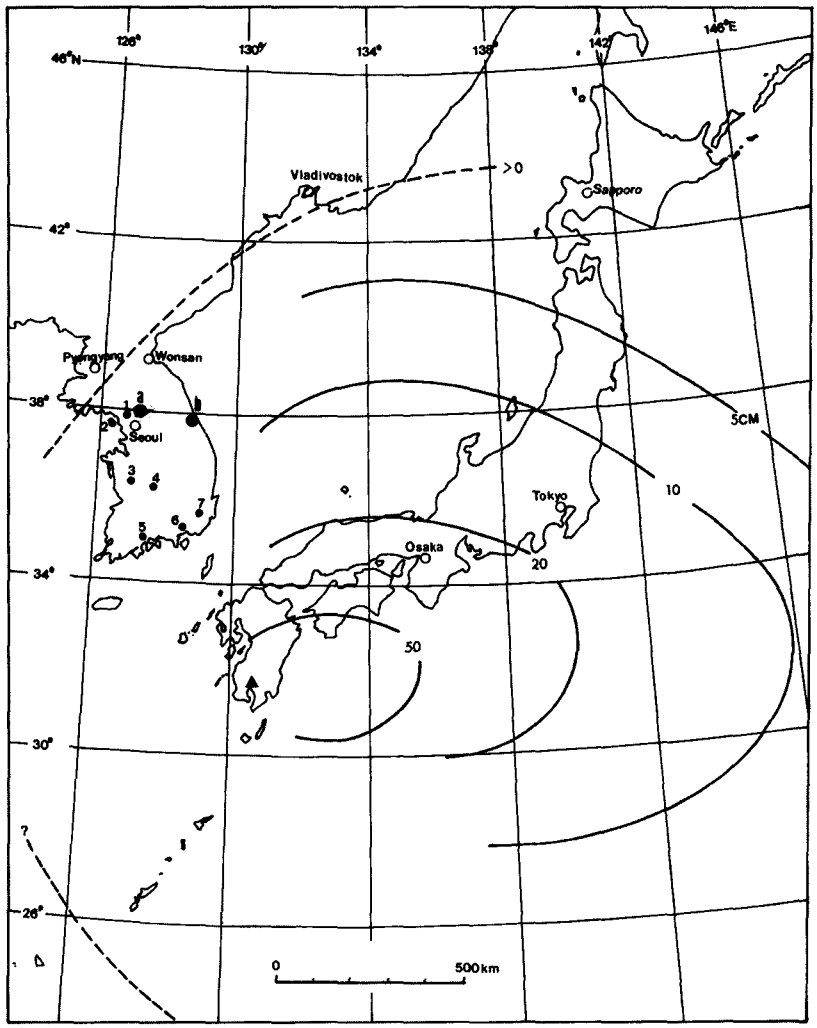

Figure 1. Isopach map of AT (modified after Machida and Arai 1992, Figiure 2.1-6). Symbols indicate Aira caldera(triangle), Chon-gok-ni(a) and Chongdongjin locality(b). Other AT localities are shown as smaller dots; 1: Kawoli; 2: Sammokdo; 3: Habongni; 4: Shindaedong; 5: Chungnaeri; 6: Naechonni, and 7: Koryeri.

an electric oven;

d) grains of 1/8 to 1/4 mm in size were taken out by sieving;

e) 500 grains were observed under microscope and volcanic glasses were tabulated according to their color and form; and

f) refractive index of volcanic glass was measured by the immersion liquid method(Arai, 1972; 1993).

So far, AT sampling has been made at a total of 11 localities. Examination of samples from two localities of Okkwa (玉果) in Koksong (谷城) and Pyongchangni (坪倉里) in Yongin (龍仁) are under way. The rest are completed, and there were detected the presence of AT from seven out of nine localities. Names of fertile localities include from north to south Sammokdo (三目島) in Inchon (仁川), Chongdongjin (正東津) in Kangnung (江陵), Shindaedong (新大洞) in Taejon (大田), Habongni (下鳳里) in Kongju (公州), Chungnaeri (竹內里) in

Posong (寶城), Koryeri (古禮里) in Miryang (密陽) and Naechonni (內村里) in Chinju (晉州). In essence, this pattern of discovery means that AT-bearing deposits do exist throughout South Korea(Fig. 1).

Of course, relative frequency of AT differs from deposit to deposit, possibly reflecting differences in depositional environment between the localities. The highest concentration of AT was detected at a Koryeri sample - here, among the 500 grains counted AT measured up to 17%, comparable to many Japanese samples. Nevertheless, such high frequency seems to be rather exceptional. At most of the localities only the mere presence of AT was confirmed, and one could count only a few grains of volcanic glass out of 500 observed. As the first report of renewed attempt to identify AT in Korea, in the follwing discussion will be described the results of analysis from two well-known localities of Chon-gok-ni and Chongdongjin.

3. Chon-gok-ni Locality

In the Imjin River basin, a number of palaeolithic localities are now known. Chon-gok-ni was the first site discovered there in 1978, and indeed represents palaeolithic occurrence of the basin. From the time of its discovery, many archaeologists shared a strong but unwarranted belief that the assemblage and the deposit should be Lower Palaeolithic, datable to two to three hundred thousand years old. Nevertheless, since the time of discovery, there has been a dispute among the researchers regarding the age(Yi, 1996).

Sampling for AT was made in front of the Chon-gok-ni exhibition hall. Here, a large portion of the deposit was exposed by a miscarried road-cut and one can easily sample the upper portion of the deposit. The exposed section reveals a number of soil units; from below to the top-soil, soil colour changes from red brown(over 90cm in thickness), reddish brown(about 30cm), dark brown(about 35cm) to yellowish brown(about 30cm). Lowermost red brown unit may be further divided into several subunits. Polygonal crack features develop at the boundary between dark brown and yellowish brown unit which run vertically down into the dark brown unit(Fig. 2). Such development of vertical cracks is regarded by some as a periglacial cryogenic feature and taken as evidence of the onset of glacial epoch(Lee, 1985, 1994; cf. Yi, 1996).

Result of analysis is shown in Table 1. From samples 1 to 9, shards of transparent and platy volcanic glass of the so-called bubble-wall type

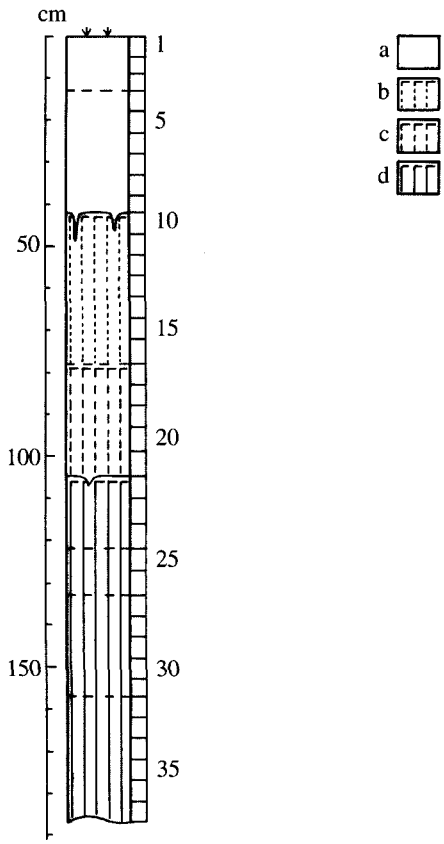

Figure 2. Columnar diagram of stratigraphic profile of Chon-gok-ni. Only the exposed section is drawn here. Numbers on the right indicate the sample number. Symbols indicate yellowish brown(a), dark brown(b), reddish brown(c) and red brown soil(d), respectively.

Table 1. Frequency of volacanic glasses at Chon-gok-ni site

Sample Number	bw (cl)	bw (pb)	bw (br)	md	pm	others	total
1	2	0	0	0	0	498	500
3	3	0	0	0	0	497	500
5	3	0	0	0	0	497	500
7	1	0	0	0	0	499	500
9	1	0	0	0	0	499	500
11	0	0	0	0	0	500	500
13	0	0	0	0	0	500	500
15	0	0	0	0	0	500	500
17	0	0	0	0	0	500	500
19	0	0	0	0	0	500	500
21	0	0	0	0	0	500	500
23	0	0	0	0	0	500	500
25	0	0	0	0	0	500	500
27	0	0	0	0	0	500	500
29	0	0	0	0	0	500	500
31	0	0	0	0	0	500	500
33	0	0	0	0	0	500	500
35	0	0	0	0	0	500	500
37	0	0	0	0	0	500	500

bw : bubble-wall type　　md : medium type
pm : pumice type　　cl : colorless
pb : pale brown　　br : brown

were detected(Plate 1). The highest concentration is represented by sample 3 and 5, where 3 out of 500 grains, or 0.6%, turn out to be volcanic glass. General characteristics of glass shards apparently indicate that all of them are of the same origin - i.e., AT. Result of refractive index measurement is shown in Table 2. Volcanic glass from sample

Plate 1. Volcanic glass shards of AT from Chon-gok-ni sample number 5 (x 100).

number 9 shows an index of 1.500± and the one from number 5 lies between 1.499 and 1.501 with a mode of 1.500. From sample number 37 were detected some number of heavy mineral grains, one of which turned out to be a bronzite with a refractive index lying between 1.698 and 1.703.

4. Chongdongjin Locality

The town of Chongdongjin is well known to geogrphers and other Quaternary researchers because of the unique geomorphology around the area. To the south of the town, there developed a massive coastal terrace rising upruptly to the height of 70m above the sea-level. Being usually regarded as the best-developed terrace morphology in Korea, it is sometimes regarded as the early Lower Pleistocene eustatic feature(e.g., Lee, 1985).

Table 2. Refractive index of volcanic glasses from Chon-gok-ni and Chongdongjin

Sample number		volcanic glass(n)	orthopyroxene(γ)
Chon-gok-ni	5	1.499 – 1.501 (1.500)	–
	9	1.500 ±	–
	37	–	1.698 – 1.703
Chongdongjin	5	1.499 – 1.501 (1.500)	–

Numbers within parentheses indicate mode value.

In 1984, some stone tools were found at two separate places on top of the terrace, followed by a test excavation at one of the localities(Yi, 1989). The full report has not yet appeared, but artifacts were found at the lower part of thick sediment deposit formed over gravel beds lying on the bedrock.

In May 1998, Yi and Soda visited the site and took samples from one of the archaeological localities. This locality lies at the very area where the road climbing from the town meets the flat top surface of the terrace. Here, about 4m-thick section is revealed. Actual sampling was made at two loci which are about 20m apart from each other because of difficulty of access to the section. AT was found from the upper part of the section, which is about 130cm-long. This part is made of grey to red brown sediments and may be divided into several soil layers(Fig. 3).

Table 3 indicates the distribution of volcanic glass identified from the upper section. Five out of eleven samples analyzed were found to contain colorless, transparent and platy volcanic glass of the bubble-wall type(Plate 2). Especially, from sample 5 were counted 6.2% of glass shards out of

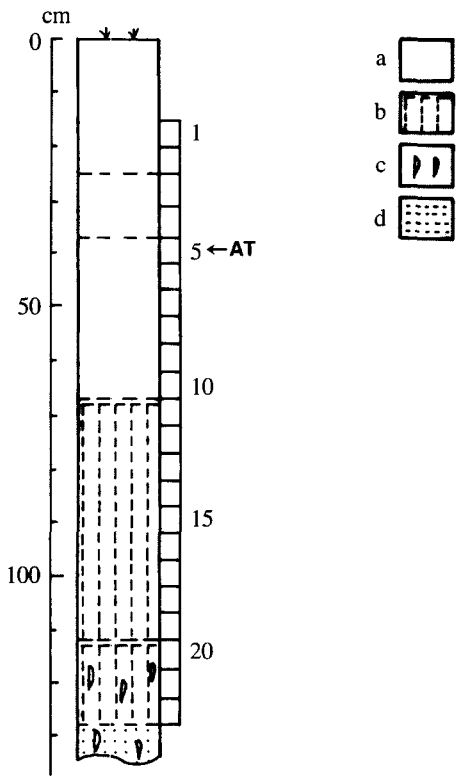

Figure 3. Columnar diagram of stratigraphic profile of Chongdongjin. Only the uppermost part is drawn here. Numbers on the right indicate the sample number. Symbols indicate greyish brown soil(a), red brown soil(b), vertical cracks(c) and heavily mottled soil(d), respectively.

Table 3. Frequency of volacanic glasses at Chongdongjin locality (uppermost part)

Sample Number	bw (cl)	bw (pb)	bw (br)	md	pm	others	total
1	3	0	0	0	0	497	500
3	7	0	0	0	0	493	500
5	29	2	0	0	0	469	500
7	4	0	0	0	0	496	500
9	0	0	0	0	0	500	500
11	1	0	0	0	0	499	500
13	0	0	0	0	0	500	500
15	0	0	0	0	0	500	500
17	0	0	0	0	0	500	500
19	0	0	0	0	0	500	500
21	0	0	0	0	0	500	500

bw : bubble-wall type　　md : medium type
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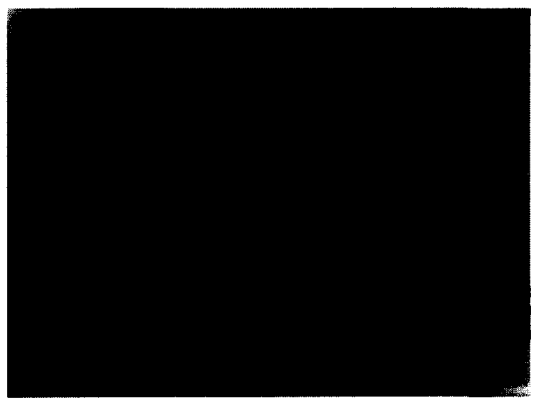

Plate 2. Volcanic glass shard of AT from Chongdongjin sample number 5 (x 100).

500 grains, making it a peak in distribution. Their refractive index turned out to lie between 1.499 and 1.501 with a mode of 1.500(Tab. 2). The pattern of frequency distribution of volcanic glass shards suggest that AT fall-out probably had occurred at the timing of deposition of the sample number 5, which stratigraphically lies about 2m above the lithic discovery of 1984.

5. Discussion

Discovery of AT at Chon-gok-ni and Chongdongjin means that sedimentation at these important Pleistocene localities continued well into the late Upper Pleistocene. In both cases, stratigraphic position of AT lies below the top level so that deposition should have continued up close to 20,000± BP time range.

For Chon-gok-ni, it means that the widely-held notion of Lower Palaeolithic status of lithic assemblage must now be discarded. It appears that archaeologists must answer for why such archaic feature in assemblage compostion continued till such a 'late' time range in Korea(Yi, 1996). Similarly, discovery of AT at Chongdongjin terrace locality is also a surprise. Although detailed examination of various evidence must be made in future, it seems to indicate the possibility that this coastal terrace might have been formed much later than usually considered - one cannot even rule out the possibility that it could be a tectonic feature formed sometime after the AT fall-out.

Discovery of AT at these two and other localities exemplifies that AT can be detected with ease and that widespread tephras will prove to be an important means for Quaternary research in Korea. It would perhaps allow one to attempt a late Pleistocene pedostratigraphical correlation across the country, which so far appeared virtually impossible in the absence of reliable datum and/or marker. If this is the case, researchers of many related fields of Quatenary study would benefit a lot from AT and other widespread tephras.

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