Title: Fission-Track Ages of the Villavieja Formation of the Miocene Honda Group in La Venta, Department of Huila, Colombia

Author(s): Takemura, Atsushi; Takai, Masanaru; Danhara, Tohru; Setoguchi, Takeshi

Citation: Kyoto University overseas research reports of new world monkeys (1992), 8: 19-27

Issue Date: 1992

URL: http://hdl.handle.net/2433/199688

Type: Article

Textversion: publisher
INTRODUCTION

Tertiary continental sediments are widely exposed along the valley of Magdalena River between the Central and the Eastern Cordillera, Colombian South America. Moreover, the Tatacoa Red Member of the Villavieja Formation is considered to be the uppermost part of the Honda Group in the La Venta badlands, which are located along the valley of Magdalena River.

GEOLOGICAL SETTING AND MATERIAL

A cooperative paleontological survey organized by the Primate Research Institute of Kyoto University and INGEOMINAS was carried out in 1990. More than 200 fossils of monkey teeth were excavated from the Tatacoa Red Member of the Villavieja Formation in the Honda Group. The upper pendants of fossil monkeys obtained in this study are correlated to the Friasian Stage of South American Land Mammal Ages (Marshall et al., 1977).

In this paper, we made detailed stratigraphic work on the Tatacoa Red Member and fission-track dating of three samples from this unit. Because the obtained ages range from 12.6 to 13.6 Ma, it is concluded that the upper part of the Honda Group in the La Venta badlands was deposited during Middle Miocene.
We use the stratigraphic framework proposed by Takai et al. (1992), because the unit names described by Fields (1959) were informal formations and members. Takai et al. (1992) renamed the stratigraphic units of Fields (1959) and modified the stratigraphy made by Honda Group exposed in the La Venta badlands. Several lithostratigraphic studies had been reported on the Honda Group in this area. Fields (1959) proposed stratigraphic framework of the Honda Group exposed in the La Venta badlands. Van Houten and Travis (1968) and Wellman (1970) studied stratigraphy and sedimentology of the whole Honda Group excluding the Honda Group from Chiquin in La Dorada, and the stratigraphy of the whole Honda Group from Honda Group exposed in the La Venta badlands. Takemura (1983) had studied detailed stratigraphy around the Kioto Site in Llanos de Molina (Fig. 2).

Takai and Setoguchi (1990) carried out detailed stratigraphic work on the Honda Group exposed in the La Venta badlands. They had modified the stratigraphy made by Fields (1959). Honda Group exposed in the La Venta badlands. Several lithostratigraphic studies had been reported on the Honda Group in this area. Fields (1959) proposed stratigraphic framework of the Honda Group exposed in the La Venta badlands. Van Houten and Travis (1968) and Wellman (1970) studied stratigraphy and sedimentology of the whole Honda Group excluding the Honda Group from Chiquin in La Dorada, and the stratigraphy of the whole Honda Group from Honda Group exposed in the La Venta badlands. Takemura (1983) had studied detailed stratigraphy around the Kioto Site in Llanos de Molina (Fig. 2).

Takai et al. (1992) renamed the stratigraphic units of Fields (1959) and modified the stratigraphy made by Honda Group exposed in the La Venta badlands. Several lithostratigraphic studies had been reported on the Honda Group in this area. Fields (1959) proposed stratigraphic framework of the Honda Group exposed in the La Venta badlands. Van Houten and Travis (1968) and Wellman (1970) studied stratigraphy and sedimentology of the whole Honda Group excluding the Honda Group from Chiquin in La Dorada, and the stratigraphy of the whole Honda Group from Honda Group exposed in the La Venta badlands. Takemura (1983) had studied detailed stratigraphy around the Kioto Site in Llanos de Molina (Fig. 2).

We use the stratigraphic framework proposed by Takai et al. (1992), because the unit names described by Fields (1959) were informal formations and members. Takai et al. (1992) renamed the stratigraphic units of Fields (1959) and modified the stratigraphy made by Honda Group exposed in the La Venta badlands. Several lithostratigraphic studies had been reported on the Honda Group in this area. Fields (1959) proposed stratigraphic framework of the Honda Group exposed in the La Venta badlands. Van Houten and Travis (1968) and Wellman (1970) studied stratigraphy and sedimentology of the whole Honda Group excluding the Honda Group from Chiquin in La Dorada, and the stratigraphy of the whole Honda Group from Honda Group exposed in the La Venta badlands. Takemura (1983) had studied detailed stratigraphy around the Kioto Site in Llanos de Molina (Fig. 2).
Figure 2. Topographic map around the Tatacoa Desert showing the localities of sample sites for fission-track dating and occurrences of fossil monkeys (x). Filled circles indicate the localities of the geological columns shown in Fig. 3.
Las Mesitas Formation

22

Tatacoa Desert Member

zo | q | E | EOL

FT site

Figure 3. Columnar sections of the Tatacoa Red Member in the Tatacoa Desert. The width of each column in these columnar sections indicates the grain size. The locality of each column is shown in Fig. 2.

The Honda Group in the La Venta badlands is divided into three formations, the Cervetana Formation, the Villavieja Formation and the Las Mesitas Formation, in ascending order.

The Las Mesitas Formation corresponds to the "Las Mesitas Sands and Clays" of Fields (1959) and Takai and Setoguchi (1990), and the Cervetana Formation corresponds to the "El Libano Sands and Clays" of Fields (1959) and Takai and Setoguchi (1990), and the Villavieja Formation corresponds to the "Cervetana Gravels and Clays" of Takai and Setoguchi (1990). The Honda Group in the La Venta badlands is divided into three formations, the Cervetana Formation, the Villavieja Formation and the Las Mesitas Formation, in ascending order.
Clay Sand

111

Figure 4. Columnar section of the Ff Site and sampling horizons for fission-track dating. The width of each layer in this column indicates the grain size.

In this column indicates the grain size.

Figure 4. Columnar section of the Ff Site and sampling horizons for fission-track dating. The width of each layer.
FISSION-TRACK DATING

The three samples collected from the Tatacoa Red Member were dated by the fission-track method. The results of this dating are shown in Table 1.

The stratigraphy of the Honda Group in the La Venta Badlands (Fig. 5) is summarized in this figure. The stratigraphy is after Takai et al. (1992), and of the Gigante Formation and Takemura & Danhara (1983) (the Gigante Formation) and Takemura & Danhara (1985) (the Molina and the Los Mangos Red Members). This layer is measured within the Tatacoa Red Member. The stratigraphic band observed in the uppermost part of this outcrop. We used these samples of less than 5 cm thick of the Tatacoa Member. These samples were taken from the Tatacoa Red Member. The stratigraphic band observed in the uppermost part of this outcrop. We used these samples of less than 5 cm thick of the Tatacoa Member. These samples were taken from the Tatacoa Red Member.

FISSION-TRACK DATING

The three samples collected from the Tatacoa Red Member were dated by the fission-track method. The results of this dating are shown in Table 1.

The stratigraphy of the Honda Group in the La Venta Badlands (Fig. 5) is summarized in this figure. The stratigraphy is after Takai et al. (1992), and of the Gigante Formation and Takemura & Danhara (1983) (the Gigante Formation) and Takemura & Danhara (1985) (the Molina and the Los Mangos Red Members). This layer is measured within the Tatacoa Red Member. The stratigraphic band observed in the uppermost part of this outcrop. We used these samples of less than 5 cm thick of the Tatacoa Member. These samples were taken from the Tatacoa Red Member.

FISSION-TRACK DATING

The three samples collected from the Tatacoa Red Member were dated by the fission-track method. The results of this dating are shown in Table 1.

The stratigraphy of the Honda Group in the La Venta Badlands (Fig. 5) is summarized in this figure. The stratigraphy is after Takai et al. (1992), and of the Gigante Formation and Takemura & Danhara (1983) (the Gigante Formation) and Takemura & Danhara (1985) (the Molina and the Los Mangos Red Members). This layer is measured within the Tatacoa Red Member. The stratigraphic band observed in the uppermost part of this outcrop. We used these samples of less than 5 cm thick of the Tatacoa Member. These samples were taken from the Tatacoa Red Member.
Daigaku), Japan. Induced fission-tracks were counted on the muscovite detectors, which were etched with hydrofluoric acid. The thermal neutron fluence was monitored with an uranium dosimeter glass, NBS-SRM612.

Recently, I.U.G.S. Subcommission on Geochronology recommended the standardization of fission-track calibration (H'ford, 1990a; 1990b). We used here calibration factors (z-values) of 370 ± 4 for EDI method and 372 ± 5 for ED2, reported by Danhara et al. (1991) for the Rot Specimen Rack of the reactor of St. Paul's University.

All the samples treated here contain a significant fraction of zircon grains with extremely high density of spontaneous fission tracks. These grains can easily be distinguished from the other zircon grains with low density of spontaneous tracks. In this paper, we regarded these low-density grains as essential ones and used them for dating.

We calculated the fission-track ages of both ED1 (using internal surfaces of zircon grains and external surfaces of external detectors) and ED2 (using external surfaces of both zircon grains and external detectors). The fission-track data of zircon are sometimes influenced by uneven distribution of uranium within each zircon crystal (Danhara et al., 1991). However, our age data show that the age values calculated from ED1 and ED2 methods are nearly equal in all samples. Therefore, we used the mean value of both ED1 and ED2 methods for age determinations in this paper.

The results are as follows in descending order:

**Table 1. Results of fission-track dating in the Tatacoa Red Member.**

<table>
<thead>
<tr>
<th>Sample number of Ps (Ns)</th>
<th>Pi (Ni)</th>
<th>Pi (Nd)</th>
<th>r</th>
<th>U</th>
<th>Mean ± 2σ (Ma)</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 004</td>
<td>0.7</td>
<td>0.5</td>
<td>2</td>
<td>3</td>
<td>13.6 ± 0.5</td>
<td>EDI</td>
</tr>
<tr>
<td>Sample 002</td>
<td>0.7</td>
<td>0.5</td>
<td>2</td>
<td>3</td>
<td>13.6 ± 0.7</td>
<td>EDI</td>
</tr>
<tr>
<td>Sample 003</td>
<td>0.5</td>
<td>0.3</td>
<td>2</td>
<td>3</td>
<td>13.6 ± 0.5</td>
<td>EDI</td>
</tr>
</tbody>
</table>

Note: All data were measured using TRIGA MARK II nuclear reactor of St. Paul's University (Rikkyo Daigaku).

(1) p and N are the density and the total number of fission tracks counted, respectively.

(2) Analyses were made by the external method using geometric factors of 0.5 and 1 for ED1 (EDI) and 2.0 for ED2 (ED2), respectively.

(3) Ages were calculated using a dosimeter glass SRM612 and age calibration factors (EDI) = 370 ± 4 and (ED2) = 372 ± 5.

(4) P(X) is the probability of obtaining the X2-value for degrees of freedom (where V = number of crystals - 1).

(5) F(EDI) = 370 ± 4 and F(ED2) = 372 ± 5.

(6) P(X) = the probability of obtaining the X2-value for degrees of freedom (where V = number of crystals - 1).

(7) Samples were irradiated using TRIGA MARK II nuclear reactor of St. Paul's University (Rikkyo Daigaku), Japan.
DISCUSSION

The resulting three ages, indicating Middle Miocene age by the fission-track method, are nearly identical. Takemura and Danhara (1985) reported fission-track ages from three horizons in the Villavieja Formation. Sample LV 13 with an age of 15.7 ± 1.1 Ma was taken from the Los Mangos Red Member and Samples KS 4 and LV 8 with respective ages of 14.6 ± 1.1 Ma and 16.1 ± 0.9 Ma were from the Molina Member of Takai et al. (1992). Although these age values seem to be somewhat older than the ages obtained in this paper, all the ages are similar considering their errors.

Fission track ages in this paper were obtained from samples of tuffaceous sandstone or mudstone. The zircon grains within these samples had been more or less transported from their origins and sedimented in the La Venta badlands. Therefore, the geological age of the sedimentation of the Tatacoa Red Member should be somewhat younger than the fission-track ages.

Takemura and Danhara (1983) dated pumices in volcanic sediments from the Gigante Formation and reported fission-track ages of 7.1 ± 0.7 Ma and 7.8 ± 0.5 Ma. The difference of these two values corresponds to two possible ways of grouping the grain-by-grain ages within the sample. These two values are nearly equal and are concordant with the age of the Gigante Formation (8.5 ± 0.4 Ma) reported by Van Houten (1976) using the K-Ar method. Because the Gigante Formation unconformably overlies the Honda Group (Takemura, 1983), the geological age of the Honda Group is older than the ages obtained from the Gigante Formation of Late Miocene age.

Severe stratigraphic studies were made on the Honda Group in the La Venta badlands (Fields, 1959; Van Houten and Travis, 1968; Wellman, 1970; Takai and Setoguchi, 1990; Takai et al., 1992). According to these studies, neither unconformities nor distinct facies changes occur within the Honda Group in this area. Therefore, no large time-gap should exist within the Honda Group in the La Venta badlands.

ACKNOWLEDGMENTS

We thank Mr. Hiroyuki Maeda of Department of Geology and Mineralogy, Faculty of Science, Kyoto University for his help in sampling and panning in Villavieja. We also thank Dr. Masao Kasuya of Kyoto Fission-Track Ltd. for critically reading the manuscript and Dr. Keiji Takemura for valuable discussion and comments.

The first author especially thanks Prof. Akira Tokuyama, Associate Prof. Toshiharu Nishimura and Dr. Yasuhiro Shibue for their assistance to carry out this study.

REFERENCES


