



**Table S2.** List of molluscan fossils collected from the Moeshima Shell Bed, location 1 and the Lower Shinjima Silt Bed, location 3.

| <b>Moeshima Shell Bed (Location 1)</b>   |  |
|--|--|
| <i>Adamnestia japonica</i> (A. Adams) クダマキガイ   | <i>Meiocardia tetragona</i> (A. Adams) コウホネガイ                    |
| <i>Anachis</i> cf. <i>amirantium</i> (Smith) ベニシワマツムシガイ?   | <i>Mitrella burcardi</i> (Dunker) コウダカマツムシロガイ                    |
| <i>Anisocorbula scaphoides</i> (Hinds) ツマベニガイ  | <i>Nebularia inquinata</i> (Reeve) フデガイ                          |
| <i>Antalis weinkauffi</i> (Dunker) ツノガイ  | <i>Nemocardium bechei</i> (Reeve) キンギョガイ                         |
| <i>Baryspira rubiginosa albocallosa</i> (Lischke) リュウグウボタルガキ   | <i>Neopycnodonta musashiana</i> (Yokoyama) ベッコウガキ                |
| <i>Bathylitina armata</i> (A. Adams) ミヒカリヒメカタベガイ   | <i>Paphia schnellina</i> (Dunker) オオスダレガイ                        |
| <i>Benimakia</i> cf. <i>fastiginda</i> (Reeve) ベニマキガイ  | <i>Paraclathurella gracilent a</i> (Smith) スノメツブ                 |
| <i>Cancilla Isabella</i> (Swainson) カラフデガイ   | <i>Pecten sinensis</i> Sowerby ハナイタヤ                             |
| <i>Cardita nodulosa</i> Lamarck モモイロトマヤガイ  | <i>Phlyctiderm japonicum</i> (Pilsbry) ヤエウメノハナガイ                 |
| <i>Cerithium kobelti</i> Dunker コオロギガイ   | <i>Phos hirasei</i> Sowerby ヒメトクサバイ                              |
| <i>Chlamys irregularis</i> (Sowerby) ナデシコガイ  | <i>Pitar noguchii</i> Home シロウネハマグリ                              |
| <i>Cleobula quercina</i> (Solander) ロウソクガイ   | <i>Pteropurpura ploraton</i> (A. Adams) タカノハヨウラクガイ               |
| <i>Cryptopecten vesiculosus</i> (Dunker) ヒヨクガイ   | <i>Reticunassa fratercula</i> (Dunker) クロスジムシロガイ                 |
| <i>Ctenocardia victor</i> (Angas) アサヒザルガイ  | <i>Sarepta speciose</i> A. Adams ヒラソデガイ                          |
| <i>Elaeocyma (Splendrilla) braunsi</i> (Yokoyama) リンドウクダマキガイ   | <i>Semele zubeensis</i> (Hanley) アサジガイ                           |
| <i>Emarginula fragilis</i> (Yokoyama) バグタエスソキレガイ   | <i>Serpulobis xenophora</i> Habe リュウグウカズラ                        |
| <i>Euspira plicispira</i> (Kuroda) キザミタマツメタガイ  | <i>Spinearca fausta</i> (Habe) モエシマミミガイ                          |
| <i>Inquisitor</i> cf. <i>flavidula</i> (Lamarck) タケノコシヤジクガイ?   | <i>Symnola (Colsyrnola) toshimana</i> (Yokoyama) トシマホソクチキレ       |
| <i>Limaria hakodatensis</i> (Tokunaga) フクレユキミノガイ   | <i>Telasco sufflatus</i> (Gould) ヨフバイの幼形                         |
| <i>Lucinoma annulata</i> (Reeve) ツキガイモドキ   | <i>Tonna luteostoma</i> (Kuster) ヤツシロガイ                          |
| <i>Lutraria sieboldii</i> Deshayes ヒラカモジガイ   | <i>Turbonilla (Paramornula) semicolorata</i> Yokoyama ソメワケイトカゲギリ |
| <i>Macoma nipponica</i> (Tokunaga) ニホンシラトリガイ   | <i>Xenoroturis millepunctata</i> (Sowerby) カスリクダマキガイ             |
| <i>Meiocardia lamarcki</i> (Reeve) テリコウボネガイ  |  |
| Collected by Azusa Uryu of Kagoshima University and identified by Prof. Emeritus Kenshiro Ogasawara of Tsukuba University                          |  |
| <b>Lower Shinjima Silt Bed (Location 3)</b>  |  |
| <i>Acteon siboldii</i> (Reeve) オオシイノミガイ  | <i>Myadora</i> sp.   |
| <i>Anomia chinensis</i> Philippi ナミマガシワガイ  | <i>Nemocardium</i> cf. <i>bechei</i> (Reeve) キンギョガイ              |
| Cf. <i>Bathymussium jeffreysi</i> (Smith) ハナヤツキヒガイの幼形?   | <i>Neverita reiniana</i> (Dunker) ハナツメタガイ                        |
| <i>Boreotrophon canlabrum</i> (Reeve) ツノオリイレガイ   | <i>Omniglypta cerina</i> (Pilsbry) ハリツオガイ                        |
| <i>Crenulilimopsis oblonga</i> (A. Adams) ナミジワシラスナガイ   | <i>Placamen tiara</i> (Dillwyn) ハナガイ                             |
| Cf. <i>Cryptopecten vesiculosus</i> (Dunker) ヒヨクガイの幼生  | <i>Phos ?</i> sp. トクサバイの仲間?                                      |
| <i>Euspira plispira</i> (Kuroda) キザミタマツメタガイ  | <i>Portlandia</i> cf. <i>japonica</i> (A. Adam) ベッコウキララガイ        |
| <i>Hiatella orientalis</i> (Yokoyama) キムマトイガイ  | <i>Sarepta japonica</i> A. Adams ヒラソデガイ                          |
| <i>Lunella</i> sp. スガイの仲間  | <i>Tucetilla pilsbryi</i> (Yokoyama) ビロウドタマキガイ                   |
| <i>Myadora fluctuosa</i> (Golud) ミツカドカタビラガイ  | <i>Tucetilla</i> sp.   |
| Collected by Kimihiro Uchimura and Kazuhiko Kano of Kagoshima University and identified by Prof. Emeritus Kenshiro Ogasawara of Tsukuba University |  |

**Table S3.** Refractive indices of constituent minerals in the tephras from Shinjima Island.

| Rock or unit name           | Locality no. and name                       | Sample no.      | Material       | Orthopyroxene  |                           |             | Volcanic glass |                           |             |             |       |
|-----------------------------|---|-----------------|----------------|----------------|---------------------------|-------------|----------------|---------------------------|-------------|-------------|-------|
|                             |   |                 |                | Range          | Average                   | n           | Range          | Average                   | n           |             |       |
| Southern Shinjima<br>Pumice | 1 East coast of southern<br>Shinjima Island | 15012008        | Pumice lapilli | 1.743–1.751    | 1.747                     | 5           | 1.499–1.504    | 1.501                     | 51          |             |       |
|                             |   |                 |                | 1.753–1.762    | 1.759                     | 55          | 1.506–1.507    | 1.506                     | 7           |             |       |
|                             |   |                 |                |                |                           |             | 1.509–1.512    | 1.511                     | 2           |             |       |
|                             |   |                 | Ash            | 1.704–1.708    | 1.706                     | 17          | 1.495–1.497    | 1.496                     | 2           |             |       |
|                             |   |                 |                | 1.709–1.712    | 1.710                     | 21          | 1.498–1.501    | 1.500                     | 25          |             |       |
|                             |   |                 |                | 1.714–1.717    | 1.715                     | 2           | 1.502–1.506    | 1.504                     | 19          |             |       |
|                             | 2 East coast of middle<br>Shinjima Island   | 15012009        | Pumice lapilli | 1.729–1.731    | –                         | 2           | 1.500–1.504    | 1.502                     | 60          |             |       |
|                             |   |                 |                | 1.746–1.756    | 1.752                     | 20          |                |                           |             |             |       |
|                             |   |                 |                | 1.757–1.763    | 1.761                     | 38          |                |                           |             |             |       |
|                             | 4 West coast of northern<br>Shinjima Island | 12050408        | Single pumice  | 1.743–1.761    | 1.755                     | 60          | 1.498–1.511    | 1.506                     | 68          |             |       |
|                             |   |                 |                |                |                           |             |                |                           |             |             |       |
|                             |   |                 |                |                |                           |             | 1.706–1.710    | 1.708                     | 44          | 1.492       | 1     |
|                             |   |                 |                |                |                           |             | 1.717–1.718    | 1.717                     | 3           | 1.497–1.501 | 1.500 |
|                             |   |                 |                |                |                           | 1.732–1.733 | 1.733          | 2                         | 1.502–1.507 | 1.504       | 18    |
|                             |   |                 |                |                |                           | 1.747–1.760 | 1.756          | 11                        | 1.508–1.510 | 1.509       | 6     |
| 12071601                    | Ash   | 1.702–1.703     | 1.702          | 2              | 1.491                     |             | 1              |                           |             |             |       |
|                             |   | 1.706–1.712     | 1.708          | 38             | 1.496–1.501               | 1.500       | 32             |                           |             |             |       |
|                             |   | 1.732–1.733     | 1.732          | 2              | 1.502–1.507               | 1.504       | 17             |                           |             |             |       |
|                             |   | 1.747–1.760     | 1.757          | 18             | 1.508–1.510               | 1.509       | 12             |                           |             |             |       |
| Shinjima Pumice             | –   | Shinjima Island | –              | Pumice lapilli | 1.759–1.761 <sup>1)</sup> |             |                | 1.500–1.501 <sup>1)</sup> |             |             |       |
|                             |   |                 |                |                | 1.740–1.760 <sup>2)</sup> |             |                | 1.499–1.503 <sup>2)</sup> |             |             |       |
| Sz-14                       | –   | –               | –              | Pumice lapilli | 1.706–1.712 <sup>2)</sup> |             |                | 1.509–1.513 <sup>2)</sup> |             |             |       |

\* Refractive indices were measured by Kyoto Fission Track Co., Ltd. according to the method of Danhara (2003) other than reported by 1) Kano et al. (1996) and 2) Machida and Arai (2003).

\*\* Refractive indices identical to those of Sz-14 are colored in blue and those of Southern Shinjima Pumice and Shinjima Pumice are colored in red.

**Table S4.** Bulk chemical compositions of pumice samples collected from the Moeshima Shell Bed and Sz-12 and Sz-13 tephtras at location 1.**XRF analyses in weight %**

| Geologic unit                  | Sz-13    | Sz-12     | Moeshima Shell Bed |             |                 |             |             |             |             |             |
|--------------------------------|----------|-----------|--------------------|-------------|-----------------|-------------|-------------|-------------|-------------|-------------|
|                                |          |           | Lower              |             | Uppermost Lower |             | Middle      |             | Upper       |             |
| Material                       | Pumice   | Pumice    | Pumice             | Pumice      | Pumice          | Pumice      | Pumice      | Pumice      | Pumice      | Pumice      |
| Sample no.                     | 12071607 | 120704-3B | 16121101-01        | 16121101-02 | 16121101-03     | 16121101-04 | 16121101-05 | 16121101-06 | 16121101-07 | 16121101-08 |
| SiO <sub>2</sub>               | 65.48    | 64.08     | 63.64              | 63.47       | 62.91           | 63.49       | 64.95       | 65.28       | 63.13       | 65.00       |
| TiO <sub>2</sub>               | 0.54     | 0.61      | 0.59               | 0.60        | 0.61            | 0.59        | 0.65        | 0.70        | 0.61        | 0.56        |
| Al <sub>2</sub> O <sub>3</sub> | 15.52    | 14.83     | 15.38              | 15.33       | 15.73           | 15.84       | 15.34       | 15.14       | 15.94       | 15.44       |
| FeO                            | 4.46     | 5.30      | 4.51               | 5.18        | 5.74            | 5.25        | 5.25        | 5.74        | 5.17        | 4.30        |
| MnO                            | 0.13     | 0.13      | 0.12               | 0.13        | 0.13            | 0.13        | 0.13        | 0.14        | 0.13        | 0.11        |
| MgO                            | 1.30     | 1.43      | 1.47               | 1.53        | 1.85            | 1.70        | 1.30        | 1.38        | 1.88        | 1.28        |
| CaO                            | 4.28     | 4.35      | 4.45               | 4.44        | 5.08            | 5.09        | 4.29        | 4.20        | 5.06        | 4.21        |
| Na <sub>2</sub> O              | 3.69     | 3.47      | 3.53               | 3.57        | 3.47            | 3.53        | 3.81        | 3.88        | 3.46        | 3.66        |
| K <sub>2</sub> O               | 2.35     | 2.26      | 2.22               | 2.21        | 2.08            | 2.14        | 2.28        | 2.29        | 2.08        | 2.30        |
| P <sub>2</sub> O <sub>5</sub>  | 0.13     | 0.15      | 0.13               | 0.14        | 0.14            | 0.14        | 0.16        | 0.19        | 0.14        | 0.14        |
| Total                          | 97.89    | 96.61     | 96.04              | 96.60       | 97.74           | 97.91       | 98.16       | 98.94       | 97.60       | 97.00       |
| L.O.I.                         | 1.87     | 2.18      | 2.52               | 2.25        | 1.92            | 1.90        | 1.22        | 1.30        | 1.83        | 3.21        |

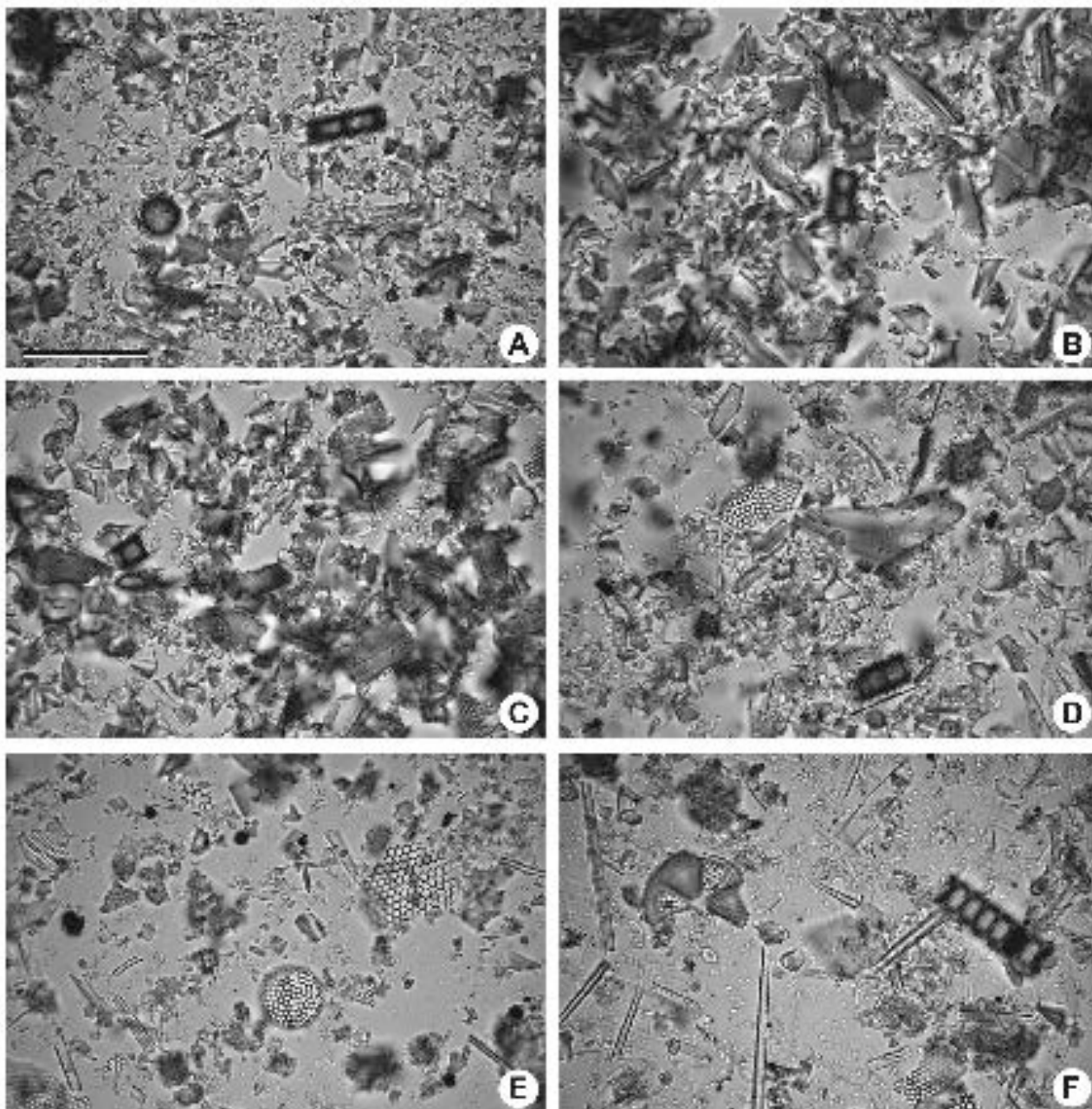
Note: XRF analysis was made by Activation Laboratories Ltd. according to a conventional glass bead method.

**Bulk chemical compositions calculated to 100 weight %**

| Geologic unit                  | Sz-13    | Sz-12     | Moeshima Shell Bed |             |                 |             |             |             |             |             |
|--------------------------------|----------|-----------|--------------------|-------------|-----------------|-------------|-------------|-------------|-------------|-------------|
|                                |          |           | Lower              |             | Uppermost Lower |             | Middle      |             | Upper       |             |
| Material                       | Pumice   | Pumice    | Pumice             | Pumice      | Pumice          | Pumice      | Pumice      | Pumice      | Pumice      | Pumice      |
| Sample no.                     | 12071607 | 120704-3B | 16121101-01        | 16121101-02 | 16121101-03     | 16121101-04 | 16121101-05 | 16121101-06 | 16121101-07 | 16121101-08 |
| SiO <sub>2</sub>               | 66.89    | 66.33     | 66.26              | 65.70       | 64.36           | 64.85       | 66.17       | 65.98       | 64.68       | 67.01       |
| TiO <sub>2</sub>               | 0.55     | 0.63      | 0.61               | 0.62        | 0.62            | 0.60        | 0.66        | 0.71        | 0.62        | 0.58        |
| Al <sub>2</sub> O <sub>3</sub> | 15.86    | 15.35     | 16.01              | 15.87       | 16.09           | 16.18       | 15.63       | 15.30       | 16.33       | 15.92       |
| FeO                            | 4.56     | 5.49      | 4.69               | 5.37        | 5.87            | 5.37        | 5.35        | 5.80        | 5.30        | 4.43        |
| MnO                            | 0.14     | 0.14      | 0.13               | 0.13        | 0.13            | 0.13        | 0.13        | 0.14        | 0.13        | 0.12        |
| MgO                            | 1.33     | 1.48      | 1.53               | 1.58        | 1.89            | 1.74        | 1.32        | 1.39        | 1.93        | 1.32        |
| CaO                            | 4.37     | 4.50      | 4.63               | 4.60        | 5.20            | 5.20        | 4.37        | 4.25        | 5.18        | 4.34        |
| Na <sub>2</sub> O              | 3.77     | 3.59      | 3.68               | 3.70        | 3.55            | 3.61        | 3.88        | 3.92        | 3.54        | 3.77        |
| K <sub>2</sub> O               | 2.40     | 2.34      | 2.31               | 2.29        | 2.13            | 2.19        | 2.32        | 2.31        | 2.13        | 2.37        |
| P <sub>2</sub> O <sub>5</sub>  | 0.13     | 0.16      | 0.14               | 0.14        | 0.14            | 0.14        | 0.16        | 0.19        | 0.14        | 0.14        |

| Geologic Unit             | Yamaguchi (1915) | Shikama (1955)     | Kino et al. (1976)                                | Kano et al. (1996)                       | Okuno et al. (1998)  | Kameyama et al. (2005)                            | Moriwaki et al. (2017)                                | This study   |                                 |                                   |
|---------------------------|------------------|--------------------|---|--|--|---|---|--|---------------------------------|-----------------------------------|
| Post-uplifting succession | (not described)  | (not described)    | Beach sand and others                             | Sandy to gravelly beach sediments        | Soil   | Beach sand, soil and Sakurajima eruption products | Beach sand and gravels, and others                    | Beach sand and others  |                                 |                                   |
|                           |                  |                    | Fallout from Sakurajima Taisho eruption           | Fallout from Sakurajima Taisho eruption  | Fallout from Sakurajima Taisho eruption                                |   | Sakurajima Taisho tephra Sz-1                         | Sakurajima Taisho Pumice Sz-1                                  |                                 |                                   |
|                           |                  |                    | Volcanic blocks from Anei submarine eruption (VB) |  | (not described)  |   | (not described)                                       | (not described)  | (VB)                            |                                   |
| Pre-uplifting succession  | Shell Bed        | Moeshima Formation | Shinjima Sirasu Bed                               | Shell and Pumice Bed                     | Moeshima Shell Bed   | Moeshima Shell Bed                                | Shinjima Shirasu                                      | Moeshima Shell Bed   |                                 |                                   |
|                           |                  |                    | Moeshima Shell Bed                                |  |  |   | Moeshima Shell Bed                                    |  |                                 |                                   |
|                           |                  |                    | Moeshima Shirasu Bed                              |  |  |   | Shell-bearing pumice lapilli tuff                     |  | Moeshima Shirasu                | Sz-11                             |
|                           | Tuff             |                    | Mudstone Bed                                      | Mudstone                                 | Silt with pumice beds S-AP and S-BP                                    | Moeshima Silt                                     | Dark grey silt with tephra Sz-14, Sz-13, Sz-12 and Yn | Upper Shinjima Silt Bed with tephra Sz-14, Sz-13, Sz-12 and Yn |                                 |                                   |
|                           |                  |                    |   | Tuffaceous siltstone                     |  |   |   | Moeshima Silt  | Grey silt and pumice (reworked) | Southern Shinjima Pumice          |
|                           |                  |                    |   | Interbedded pumice lapilli tuff and tuff |  |   |   |  | Susaki Pumice                   | Shinjima pyroclastic flow deposit |
|                           | Pumice Bed       |                    | Massive sandy pumice Bed                          | Shinjima Pumice                          | Shinjima Pumice  | Susaki Pumice                                     | Shinjima pyroclastic flow deposit                     | Shinjima Pumice  |                                 |                                   |
|                           | Tuff             |                    | Moeshima Silt Bed                                 | Mudstone and pumice Bed                  | Pumice lapilli tuff and tuff, tuffaceous sandstone-mudstone turbidites | (not described)                                   | Moeshima Silt   | Silt and others  | Lower Shinjima Silt Bed         |                                   |

Fig. S1. Comparison of previously proposed stratigraphy with the newly proposed stratigraphy



**Fig. S2.** Photomicrographs of diatom slides. Scale bar = 50  $\mu\text{m}$ .

A = Assemblage *F* (Sample 12050402, Shinjima Pumice, Loc. 2)

B = Assemblage *F* (Sample SJ12-01, Shinjima Pumice, Loc. 4),

C = Assemblage *F* (Sample 15012009, Southern Shnjima Pumice, Loc. 1)

D = Assemblage *FM* (Sample 12071607, Sz-13 tephra, Loc. 1)

E = Assemblage *M* (Sample 12070401-1, Upper Shinjima Silt Bed, Loc. 1)

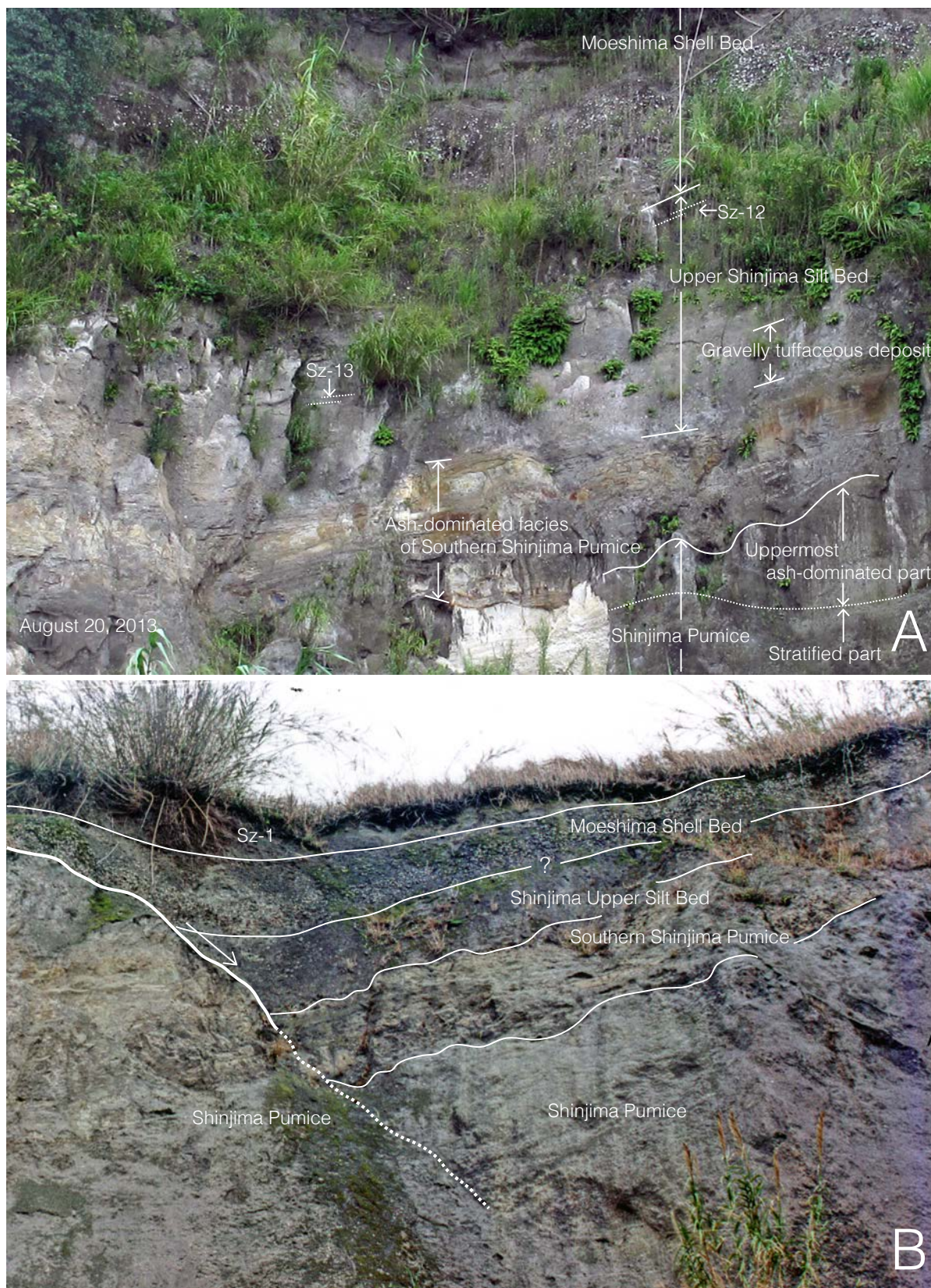
F = Assemblage *M* (Sample 12050411, Lower Shinjima Silt Bed, Loc. 4).

Assemblage *F* = Freshwater diatom assemblage with very rare marine diatoms,

Assemblage *FM* = Mixed assemblage of freshwater and marine diatoms,

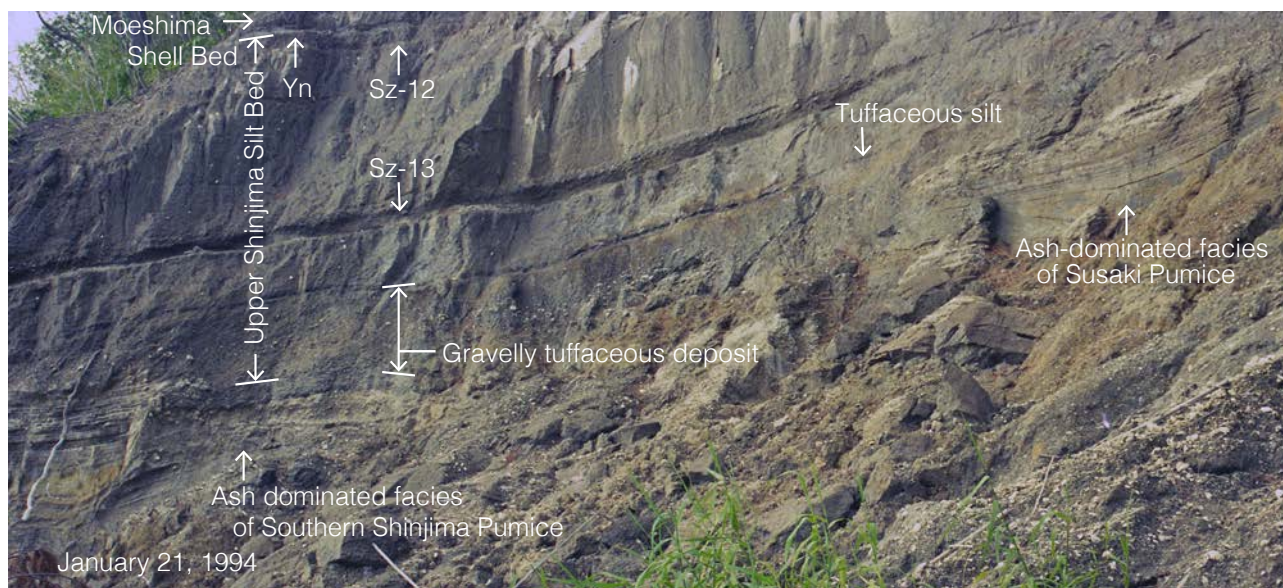
Assemblage *M* = Marine diatom assemblage with rare brackish to freshwater diatoms.





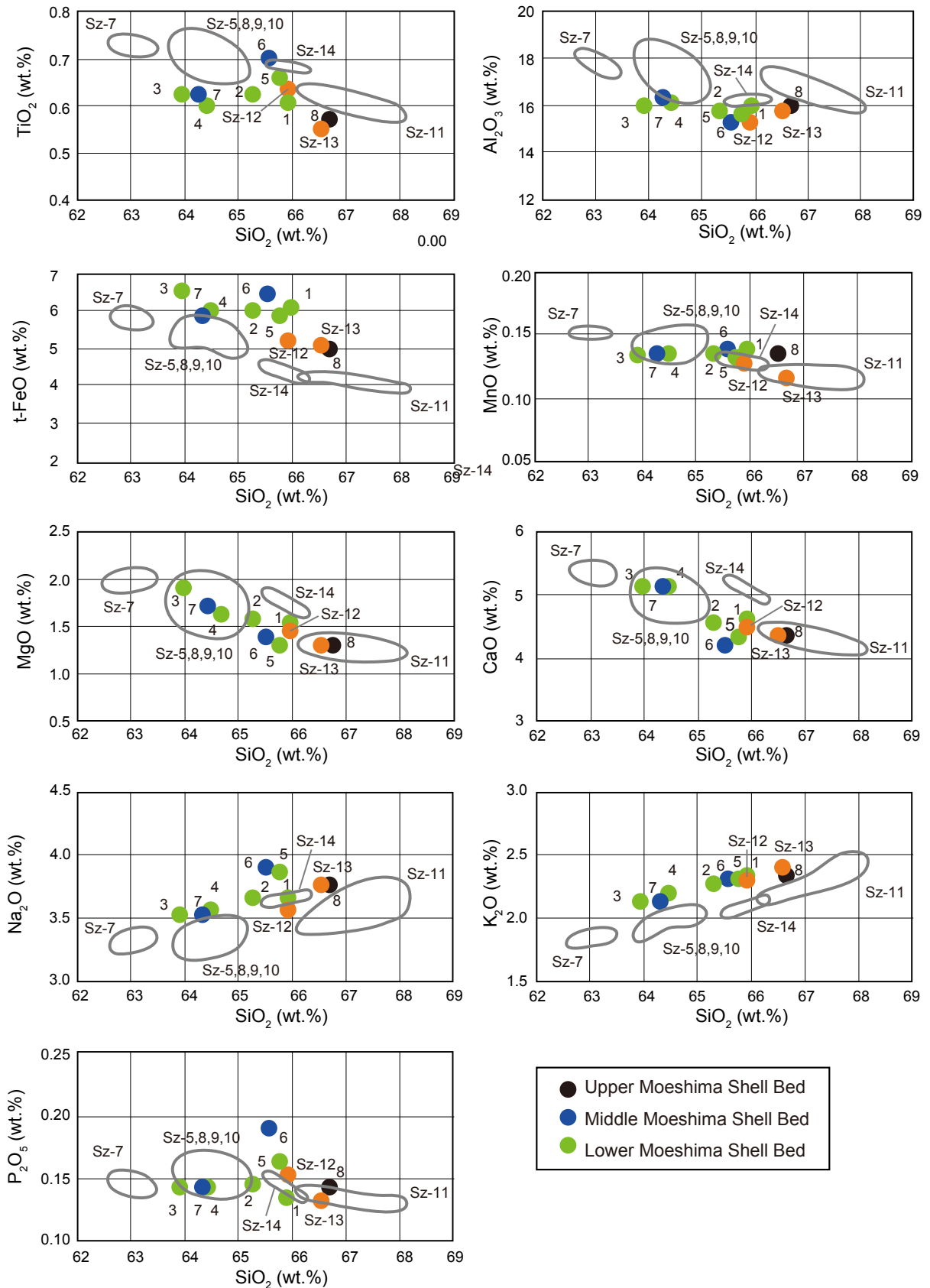
**Fig. S3.** A: A photo taken on August 20, 2013, showing the succession from the Shinjima Pumice to the Moeshima Shell Bed exposed at location 4. Gravelly tuffaceous deposits is c. 2.8 m thickness. This outcrop has been also almost covered with vegetation. B: A photo taken in 1975, showing a normal fault displacing the same succession exposed at the same location. Photo courtesy of Kimihiko Oki.





**Fig. S4.** A photo taken on January 21, 1994, showing the succession from the Southern Shinjima Pumice to the Moeshima Shell Bed exposed around location 1. Gravelly tuffaceous deposits is c. 1.8 m thickness. This large outcrop has been covered with embankment, talus and thick vegetation.





**Fig. S5.** Harker diagrams for the pumices from the Moeshima Shell Bed and Sz-12 and Sz-13 tephras. Numerals 1 to 8 corresponds to the last digit of sample numbers shown in Table S4. The major element compositions of Sz-5, 7, 8, 9, 10 and 11 and those of Sz-14 are adopted from Takahashi et al. (2011) and Yamamoto et al. (2013).