Report of the Okayama University of Science - Mongolian Institute of Paleontology and Geology Joint Expedition in 2016

Shinobu ISHIGAKI[1], Khishigjav TSOGTBAATAR[2], Mototaka SANEYOSHI[1,3], Buuvei MAINBAYAR[2], Kazumasa AOKI[4], Sanjaadash ULZIITSEREN[2], Takeshi IMAYAMA[3], Akio TAKAHASHI[4], Shin TOYODA[4], Chagnaa BAYARDORJ[2], Batsaikhan BUYANTEGSH[2], Jargalsaikhan BATSUKH[2], Byambaa PUREVSUREN[2], Hitomi ASAI[1], Sayaka TSUTANAGA[1] and Kohei FUJII[4]

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Abstract. We briefly report the results of the Okayama University of Science (OUS) and Institute of Paleontology and Geology, Mongolian Academy of Sciences (IPG) Joint Expedition conducted in the Gobi Desert of Mongolia during the field season of 2016. We carried out geological surveys and fossil prospection in eight Upper Cretaceous fossil localities in South Gobi Aimag, southern Mongolia. Of these, Bayshin Tsav, Khoorai Tsav, Baishin Tsav West, Amtgai, and Amtgai North which are attributed to Baynshirenian age (Late Cretaceous). Shar Tsav which is assigned to Nemegtian age (Late Cretaceous), and two newly found ichnofossil sites in the northwest of Bayshin Tsav. The age of newly found ichnosites are unknown. We also visited Khongil Tsav, Burkhant, and Baynshire (Baynshirenian age, Late Cretaceous) in East Gobi Aimag for geological reconnaissance and rock sampling. We have collected 28 plaster jackets including an egg nest at Urlibe Khuduk, partial skeleton of a hadrosauroid at Bayshin Tsav, and a hadrosauroid pelvic part at Khoorai Tsav. Many fragmental body fossils of dinosaurs and turtles were also collected. In newly found ichnosites, we discovered many dinosaur footprints including extremely large footprints of sauropod. In the field work, we have collected geological samples for physical and chemical analysis by means of LA-ICPMS (Laser Ablation Inductively Coupled Plasma Mass Spectrometry), ESR (Electron Spin Resonance), and CL (Cathodeluminescence) methods.

Abbreviations: OUS, Okayama University of Science; **IPG**, Institute of Paleontology and Geology, Mongolian Academy of Sciences; **OUS-IPG JE:** Okayama University of Science and Mongolian Institute of Paleontology and Geology Joint Expedition. (It is also abbreviated as **IPG-OUS JE**)

1. Members

The members of the expedition in 2016 were as follows:

Japanese side — total nine people:

- Shinobu ISHIGAKI (Professor, OUS, Leader of the Japanese side)
- Shin TOYODA (Professor, OUS)
- Takeshi IMAYAMA (Associate Professor, OUS)
- Akio TAKAHASHI (Associate Professor, OUS)
- Kazumasa AOKI (Lecturer, OUS)
- Mototaka SANEYOSHI (Lecturer, OUS)
- Hitomi ASAI (Graduate student, OUS)
- Sayaka TSUTANAGA (Under graduate student, OUS)
- Kohei FUJII (Under graduate student, OUS)

Mongolian side — total ten people:

- TSOGTBAATAR Khishigjav (Director of IPG, Leader of the Mongolian side)
- MAINBAYAR Buuvei (Researcher / Car (Land Cruiser) driver, IPG)
- ULZIITSEREN Sanjaadash (Collection manager, IPG)
- BAYARDORJ Chagnaa (Preparator / car (Pajero) driver, IPG)
- BUYANTEGSH Batsaikhan (Researcher, IPG)
- BATSUKH Jargalsaikhan (Researcher, IPG)
- PUREVSUREN Byambaa (Researcher, IPG)
- AMARZAYA Sodnomtsog (Cook)
- MUNKHNASAN Mungun (Track (Kamaz) driver)
- BURENDELGER Boldoo (Car (Land Cruiser) driver)

2. Schedule

The expedition was performed from 12 to 27 August 2016 (field-work days were 16 days in total). This is the second expedition of

[1] Faculty of Biosphere - Geosphere Science, Okayama University of Science, 1-1 Ridai-cho, Kita-ku, Okayama, 700-0005, Japan
[2] Institute of Paleontology and Geology, Mongolian Academy of Sciences, P.O.B: 46/650, S.Danzan Street 3/1, 4th khoroo, Chingeltei district, Ulaanbaatar - 15160, Mongolia
[3] Research Institute of Natural Sciences, Okayama University of Science, 1-1 Ridai-cho, Kita-ku, Okayama, 700-0005, Japan
[4] Faculty of Science, Okayama University of Science, 1-1 Ridai-cho, Kita-ku, Okayama, 700-0005, Japan

OUS-IPG JE following the first expedition carried out in 2015 (Saneyoshi *et al.* 2015)

August 12 morning: Left Ulaanbaatar for Khongil Tsav (Geology team) and for Bayshin Tsav (Paleontology team).

August 13: Geology team: fieldwork in Khongil Tsav. Paleontology team: arrive in Bayshin Tsav at 18:00.

August 14: Geology team: fieldwork in Burkhant and Baynshire. Trip from Baynshire to Bayshin Tsav. Paleontology team: fieldwork at Bayshin Tsav.

August 15: fieldwork at Bayshin Tsav.

August 16: fieldwork at newly found footprint site No.1, Bayshin Tsav West and Shar Tsav.

August 17: fieldwork at Amtgai (south, central). Geology group worked around Bayshin Tsav.

August 18: fieldwork at Urlibe Khuduk. Geology group worked around Bayshin Tsav.

August 19: fieldwork at Bayshin Tsav.

August 20: fieldwork at Khoorai Tsav and Bayshin Tsav West.

August 21: fieldwork at Bayshin Tsav and surrounding area. Excavation at newly found footprint site No.1, 2.7km northwest of Bayshin Tsav basecamp.

August 22: rainy day. Stay at Bayshin Tsav.

August 23: fieldwork at Shar Tsav, Amtgai North and newly found footprint site No. 2, 4.4km northwest of Bayshin Tsav. Sampling at Shar Tsav.

August 24: fieldwork at Khoorai Tsav.

August 25: fieldwork around Bayshin Tsav and newly found footprint site No.1. Sampling at Shar Tsav. Plaster jacket making in Khoorai Tsav.

August 26: plaster jackets making at Bayshin Tsav and Bayshin Tsav West.

Leave from Bayshin Tsav at 3:30.

August 27 afternoon: arrive at Ulaanbaatar

3. Locality

The localities visited and surveyed by the joint expedition party are listed below. We follow the spelling and abbreviation provided in Watabe and Suzuki (2000) and Watabe et al. (2010) for each locality and geological ages except in those cases where we quote original literature. Visited localities in Bayshin Tsav area are shown in Figure 1.

(1) Bayshin Tsav (Baynshirenian, Late Cretaceous)
(2) Bayshin Tsav West (Baynshirenian Late Cretaceous)
(3) Khoorai Tsav (Baynshirenian Late Cretaceous)
(4) Shar Tsav (Nemegtian ?, Late Cretaceous)
(5) Shar Tsav West and Far West (Nemegtian ?, Late Cretaceous)
(6) Amtgai (Baynshirenian, Late Cretaceous)
(7) Amtgai North (Baynshirenian, Late Cretaceous)
(8) Urlibe Khuduk (Baynshirenian, Late Cretaceous)
(9) New Footprint Sites close to Bayshin Tsav (2.5km and 4.5km northwest of Bayshin Tsav)

The following Localities were also visited during the trip for the purpose of geological reconnaissance and rock sampling.

(10) Khongil Tsav (Baynshirenian, Late Cretaceous)
(11) Burkhant (Baynshirenian, Late Cretaceous)

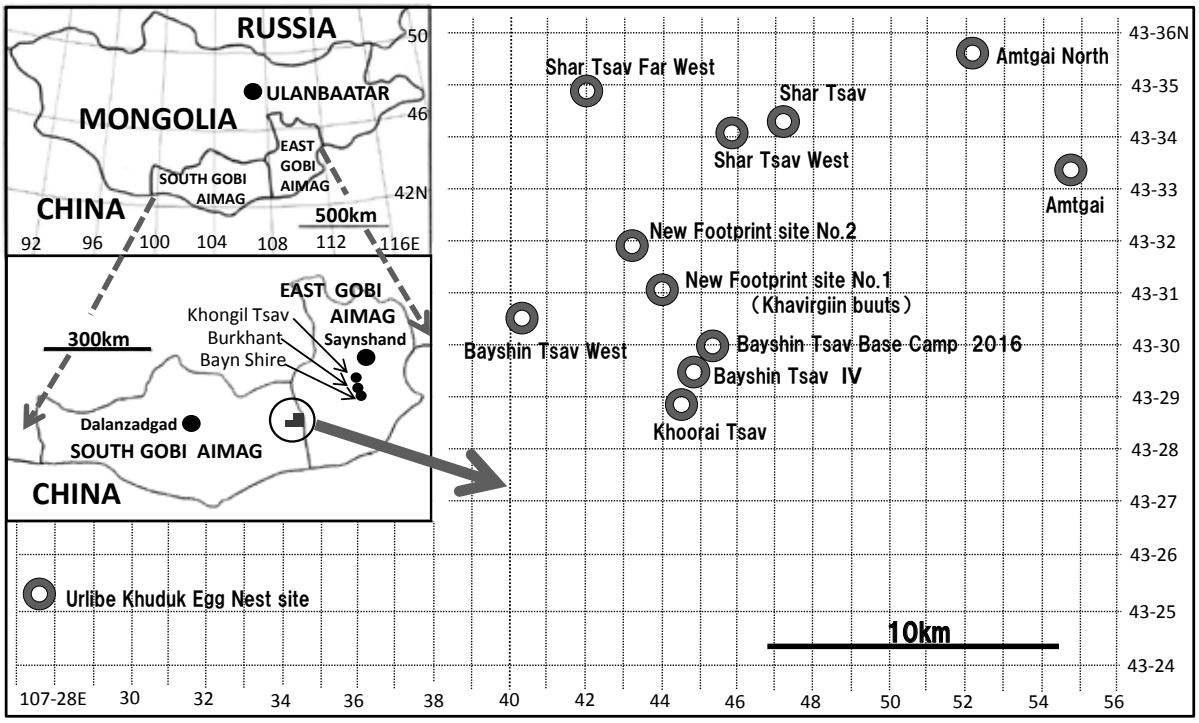

Figure 1. Map of fossil sites surrounding Bayshin Tsav basecamp of OUS-IPG JE 2016.

(12) Baynshire (Baynshirenian, Late Cretaceous)

4. Results

28 plaster jackets of dinosaur and reptile specimens, surface collection of isolated bones and fragmental fossils, and rock samples for physical and chemical analysis were collected during the expedition. They are listed in table 1, 2, and 3 respectively. The GPS data in the tables and following text are WGS 84. The geological team performed fieldwork and sampling the Bayshin Tsav area, and the Eastern Gobi region. Paleoichnological mapping in two newly found tracksites, and in newly found *Avimimus*-type footprints site in Shar Tsav were executed.

4-1. Bayshin Tsav (Baynshirenian, Late Cretaceous)

The Bayshin Tsav locality is located about 60 km north of Han Bogd Somon (South Gobi Aimag). The basecamp was settled at 43-29-57.2N, 107-45-16.6E, 903mALT.

Photographs of the locality are shown in Figure 2.

The following vertebrate fossils were discovered in the expedition of the year.

(1) Partial articulated skeleton of hadrosauroid

(2) Hind limb bones of large-sized hadrosauroid (in hard sandstone)

13 Plaster jackets were collected from the area. They are listed in Table 1 with GPS data. Disarticulated fragmental bones were also collected as surface collection. The lithology of this locality consists of sand dominated alternation of sandstone and mudstone. Bone beds including disarticulated bones were often observed in this area. The paleoenvironment of this locality is fluvial. Geological survey and rock sampling were also executed.

4-2. Bayshin-Tsav West (Baynshirenian, Late Cretaceous)

The Bayshin Tsav West locality is located about 7km west of Bayshin Tsav Locality. This site was discovered in 2015 OUS-IPG JE. This year, intensive prospection of the fossil was executed. Photographs of the locality are shown in Figure 3.

The following vertebrate fossils were discovered in the expedition of the year.

(1) Partial carapace of turtle

(2) Partial articulated skeleton (caudal part) of theropod(?).

3 Plaster jackets were collected from the area. In Bayshin Tsav West locality, the Baynshire Formation is exposed. The lithology of this locality consists of sand dominated alternation of sandstone and mudstone. Bone beds including disarticulated bones have developed in this area. Paleoenvironment of this locality is fluvial.

Table 1. List of plaster jackets collected by OUS-IPG JE in 2016

Date	Locality	Elements	Collector	Coordination	Plaster Jacket №.	Comment
160816 BTs-W	Bayshin Tsav-West	Part of turtle carapace	PRN /Purevsuren/	?	PJ-01	turtle
160816 AMT	Amtgai	Humerus of hadrosauroid	BD /Bayardorj/	43-33-31.1/107-54-39.0	PJ-02	hadrosauroid
160816 AMT	Amtgai	Metatarsal of hadrosauroid	BD /Bayardorj/	43-33-31.1/107-54-39.0	PJ-03	hadrosauroid
160816 AMT	Amtgai	Sacrum	MB /Mainbayar/	43-33-31.1/107-54-39.0	PJ-04	?theropod
160818 URB-S	Urlibe Khuduk	Egg nest	MB /Mainbayar/	43-25-24.2/107-27-34.7	PJ-05	
160818 URB	Urlibe Khuduk	?Part of skull	ULZ /Ulziitseren/	43-27-51.7/107-25-35.7	PJ-06	
160818 URB	Urlibe Khuduk	Part of turtle carapace	PRN /Purevsuren/	43-27-51.7/107-25-35.8	PJ-07	turtle
160824 KhT	Khoorai Tsav	Part of femur and fibula	Asai	43-28-55.49/107-44-24.42	PJ-08	?hadrosauroid
160824 KhT	Khoorai Tsav	Part of rib	Asai	43-28-55.49/107-44-24.42	PJ-09	
160824 KhT-Down	Khoorai Tsav	Pelvic part, vert., fragmental bone	BD /Bayardorj/	43-28-25.6/107-44-58.6	PJ-10-1/4	hadrosauroid
		Pubis	BD /Bayardorj/	43-28-25.6/107-44-58.6	PJ-10-2/4	hadrosauroid
		Pubis	BD /Bayardorj/	43-28-25.6/107-44-58.6	PJ-10-3/4	hadrosauroid
		Part of femur and tibia	BD /Bayardorj/	43-28-25.6/107-44-58.6	PJ-10-4/4	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Fibula of hadrosauroid	Asai	43-29-39.2/107-44-46.2	PJ-11	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Caudal vert	BD /Bayardorj/	43-29-44.2/107-45-0.04	PJ-12-1/3	hadrosauroid
		Femur	BD /Bayardorj/		PJ-12-2/3	hadrosauroid
		? Fragmental bone	BD /Bayardorj/		PJ-12-3/3	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Ischium of hadrosauroid	ULZ /Ulziitseren/	43-29-28.3/107-44-48.6	PJ-13	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Fibula of hadrosauroid	BTKh /Batsukh/	43-29-28.2/107-44-46.6	PJ-14	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Femur of hadrosauroid	TGSh /Buyantegsh/	43-29-28.2/107-44-46.7	PJ-15	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Dorsal Vert.	ULZ /Ulziitseren/	43-29-28.3/107-44-48.6	PJ-16	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Tibia of hadrosauroid	MB /Mainbayar/	43-29-28.2/107-29-28.2	PJ-17	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Sacrum of hadrosauroid	PRN /Purevsuren/	43-29-28.6/107-44-50.0	PJ-18	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Femur of hadrosauroid	BTKh /Batsukh/	43-29-28.8/107-44-49.7	PJ-19	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Ischium of hadrosauroid	TGSh /Buyantegsh/	43-29-29.4/107-44-49.2	PJ-20	hadrosauroid
160825 BTs-IV	Bayshin Tsav-IV	Femur of hadrosauroid	MB /Mainbayar/	43-29-32.5/107-44-50.3	PJ-21	hadrosauroid
160826 BTs-W	Bayshin Tsav-West	Caudal vert	MB /Mainbayar/	43-30-31.5/107-40-23.9	PJ-22	?theropod
160826 BTs-W	Bayshin Tsav-West	Part of skull	ULZ /Ulziitseren/	43-30-31.5/107-40-23.9	PJ-23	?
					Total 28	

Table 2. List of isolated and fragmental samples collected by OUS-IPG JE in 2016

Date	Locality	Material	Collector	Altitude	Longitude	Elevation
20160815	BsT	Fragment	ASAI	43-29-58.91	107-45-42.20	-
20160815	BsT	Fragment	Saneyoshi	43-29-44.82	107-46-08.69	-
20160816	BsT	Fragment	Tsutanaga	43-29-58.81	107-45-38.89	-
20160816	BsT West	Fragmental bones	ISGK	43-30-14.9	107-40-39.0	-
20160816	BsT West	Tooth and claw	ASAI	43-30-32.34	107-40-23.35	914
20160816	Shar Tsav West Convolution Site	Eggshell	ISGK	-	-	-
20160817	AMT	Fragmental bone	Bayardorj	43-33-32.3	107-54-44.3	-
20160817	AMT central Area	Bone fragments	ISGK	43-33-27.0	107-54-40.7	-
20160817	AMT central Area	Hadrosaaurid ulna	ISGK	43-34-27.0	107-54-40.7	862
20160818	URB	Egg shell No.4	ISGK	43-25-24.6	107-27-34.7	959.4
20160818	URB	Egg shell No.3	ISGK	43-25-24.6	107-27-34.7	959.4
20160818	URB	Egg shell No.2	ISGK	43-25-24.6	107-27-34.7	959.4
20160818	URB	Egg shell No.1	ISGK	43-25-24.6	107-27-34.7	959.4
20160818	URB South	-	Saneyoshi	43-25-35.98	107-27-22	961
20160819	BsT Ⅱ	Theropod Fragment	Takahashi	43-29-56.0	107-46-05.4	895.6
20160819	BsT Ⅳ	Fragmental bones	ISGK	-	-	-
20160820	BsT West	Hadrosauroid fibula	ISGK	43-30-31.4	107-40-21.9	914.3
20160820	BsT West	Fragmental bone	ISGK	43-30-30.5	107-40-23.6	912.7
20160820	BsT West	Fragment	ISGK	43-30-30.5	107-40-23.6	912.7
20160820	Khoorai Tsav	Fragmental bones	ISGK, ASAI	43-28-55.49	107-44-24.42	909
20160823	AMT North, Beside Sauropod Vert.	Fragmental Bones	ISGK	43-35-37.6	107-52-10.7	887.1
20160824	AMT North	Fragment	ISGK	43-20-43.9	107-44-56.6	903
20160824	Khoorai Tsav Asai-site	-	ISGK	43-28-55.49	107-44-24.42	909
20160824	Khorai Tsav Asai-site	Fragment	ISGK	43-28-55.49	107-44-24.42	909
20160824	Khorai Tsav Asai-site	Fragment	ISGK	43-28-55.49	107-44-24.42	909
20160825	BsT IV	Fragment	ASAI	43-29-31.76	107-44-49.98	-
20160825	BsT IV	Theropod claw	Fujii	43-29-39.17	107-44-46.09	-
20160825	BsT IV ASAI's site	Fragmental bones	Toyoda,Asai,Fujii, Aoki	43-29-39.2	107-44-46.2	-

Table 3. List of geological samples collected by OUS-IPG JE in 2016

Sample No.	Date	Rock type	Formation	Area	WGS84 (° ‘ ”)
20160814ESR1	2016/8/14	Sandstone	Baynshire F.	Burkhant	N44 20 22.5 E109 51 34.3
20160814ESR2	2016/8/14	Sandstone	Baynshire F.	BaynShire	N44 16 28.9 E109 54 32.6
20160814ESR3	2016/8/16	Sandstone	Nemegt F.	SharTsav West	N43 34 13.3 E107 45 35.5
20160817ESR4	2016/8/17	Sandstone	Baynshire F.	BayshinTsav	N43 29 58.2 E107 45 14.3
20160817ESR5	2016/8/17	Sandstone	Baynshire F.	BayshinTsav	N43 29 59.47 E107 45 13.11
20160817ESR6	2016/8/17	Sandstone	Baynshire F.	BayshinTsav	N43 30 00.0 E107 45 12.2
20160817ESR7	2016/8/17	Sandstone	Baynshire F.	BayshinTsav	N43 30 00.7 E107 45 09.0
20160818ESR8	2016/8/18	Sandstone	Baynshire F.	UrlibeKhuduk South	N43 25 29.7 E107 27 46.1
20160818ESR9	2016/8/18	Sandstone	Baynshire F.	UrlibeKhuduk South	N43 25 28.7 E107 27 43.1
20160823ESR10	2016/8/23	Sandstone	Nemegt F.	SharTsav	N43 36 08.8 E107 52 50.8
20160823ESR11	2016/8/23	Sandstone	Baynshire F.	Amtgai. North	N43 36 00.9 E107 51 58.4
20160823ESR12	2016/8/23	Sandstone	Baynshire F.	Amtgai. North	N43 36 08.8 E107 52 50.8
20160824ESR13	2016/8/24	Sandstone	Baynshire F.	BayshinTsav	N43 30 02.1 E107 45 56.0
20160824ESR14	2016/8/24	Sandstone	Baynshire F.	BayshinTsav	N43 30 02.1 E107 45 56.0
20160824ESR15	2016/8/24	Sandstone	Baynshire F.	BayshinTsav	N43 30 02.1 E107 45 56.0
20160824ESR16	2016/8/24	Sandstone	Baynshire F.	BayshinTsav	N43 30 02.1 E107 45 56.0
20160824ESR17	2016/8/24	Sandstone	Baynshire F.	BayshinTsav	N43 29 37.1 E107 44 42.6
20160824ESR18	2016/8/24	Sandstone	Baynshire F.	BayshinTsav	N43 29 37.1 E107 44 42.6
20160824ESR19	2016/8/25	Sandstone	Baynshire F.	BayshinTsav	N43 28 25.8 E107 44 58.3
20160824ESR20	2016/8/26	Sandstone	Baynshire F.	BayshinTsav	N43 28 25.8 E107 44 58.3
160813-01	8/13/2016	Sandstone	Baynshire F.	Khogil Tsav	N44 26 19.1 E109 51 03.6
160813-02	8/13/2016	Sandstone	Baynshire F.	Khogil Tsav	N44 26 19.1 E109 51 02.8
160813-03	8/13/2016	Sandstone	Baynshire F.	Khogil Tsav	N44 26 20.1 E109 51 02.4
160813-04	8/13/2016	Sandstone	Baynshire F.	Khogil Tsav	N44 26 20.6 E109 51 01.4
160813-05	8/13/2016	Sandstone	Baynshire F.	Khogil Tsav	N44 26 18.8 E109 50 59.1
160813-06	8/13/2016	Sandstone	Baynshire F.	Khogil Tsav	N44 26 11.9 E109 51 55.5
160814-01	8/14/2016	Sandstone	Baynshire F.	Burkhant	N44 20 23.3 E109 51 34.0
160814-02	8/14/2016	Sandstone	Baynshire F.	BaynShire	N44 16 30.7 E109 54 29.9
160814-03	8/14/2016	Sandstone	Baynshire F.	BaynShire	N44 16 20.2 E109 54 27.7
160814-04	8/14/2016	Sandstone	Baynshire F.	BaynShire	N44 16 16.2 E109 54 28.8
160814-05	8/14/2016	Sandstone	Baynshire F.	BaynShire	N44 16 30.3 E109 54 04.2
160814-06	8/14/2016	Sandstone	Baynshire F.	BaynShire	N44 16 31.5 E109 54 04.8
160815-01	8/15/2016	Basaltic rock	Baynshire F.	Bayshin Tsav	N43 29 59.1 E107 44 58.7
160815-02	8/15/2016	Sandstone	Baynshire F.	Bayshin Tsav	N43 29 58.7 E107 44 59.0
160815-03	8/15/2016	Sandstone	Baynshire F.	Bayshin Tsav	N43 29 58.6 E107 44 58.7

Sample No.	Date	Rock type	Formation	Area	WGS84 (° ‘ ”)
160815-04	8/15/2016	Basaltic rock	Baynshire F.	Bayshin Tsav	N43 29 58.6 E107 44 58.7
160815-05	8/15/2016	Sandstone	Baynshire F.	Bayshin Tsav	N43 30 00.3 E107 45 56.7
160816-01	8/16/2016	Conglomerate	Baynshire F.	Bayshin Tsav West	N43 30 14.9 E107 40 39.0
160816-02	8/16/2016	Sandstone	Baynshire F.	Bayshin Tsav West	N43 30 42.1 E107 40 18.7
160816-03	8/16/2016	Sandstone	Baynshire F.	Bayshin Tsav West	N43 34 13.4 E107 45 35.1
160816-04	8/16/2016	Sandstone	Baynshire F.	Bayshin Tsav West	N43 34 13.4 E107 45 35.0
160816-05	8/16/2016	Sandstone	Baynshire F.	Bayshin Tsav West	N43 34 12.9 E107 45 35.7
160816-06	8/16/2016	Sandstone	Baynshire F.	Bayshin Tsav West	N43 34 12.3 E107 45 34.5
160816-07	8/16/2016	Sandstone	Baynshire F.	Bayshin Tsav far West	N43 35 06.6 E107 41 30.5
160817-01	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 27 39.1 E107 47 00.7
160817-02	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 27 33.3 E107 47 03.9
160817-03	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 58.0 E107 47 28.3
160817-04	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 58.2 E107 47 30.4
160817-05	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 51.5 E107 47 44.5
160817-06	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 49.5 E107 47 41.4
160817-07	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 46.1 E107 47 39.9
160817-08	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 56.2 E107 47 28.7
160817-09	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 56.2 E107 47 22.1
160817-10	8/17/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 55.2 E107 47 22.4
160818-01	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 41.4 E107 47 03.0
160818-02	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 36.1 E107 47 05.8
160818-03	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 25.2 E107 47 10.2
160818-04	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 25.3 E107 47 07.7
160818-05	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 20.7 E107 46 55.3
160818-06	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 41.1 E107 47 11.4
160818-07	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 35 06.6 E107 41 30.5
160818-08	8/18/2016	Basaltic rock	Baynshire F.	Bayshin Tsav far SE	N43 26 28.8 E107 47 50.2
160818-09	8/18/2016	Volcanic sedimentary rock	Baynshire F.	Bayshin Tsav far SE	N43 25 14.6 E107 41 18.2
160818-10	8/18/2016	Sandstone	Baynshire F.	Bayshin Tsav far SE	N43 25 18.9 E107 41 11.0
160818-11	8/18/2016	Sandstone	Baynshire F.	Bayshin Tsav far SE	N43 25 19.2 E107 41 07.5
160819-01	8/19/2016	Volcanic sedimentary rock	Baynshire F.	Bayshin Tsav far SE	N43 25 14.2 E107 43 13.6
160819-02	8/19/2016	Volcanic sedimentary rock	Baynshire F.	Bayshin Tsav far SE	N43 25 09.9 E107 43 21.0
160819-03	8/19/2016	Volcanic sedimentary rock	Baynshire F.	Bayshin Tsav far SE	N43 25 10.0 E107 43 21.0
160819-04	8/19/2016	Volcanic sedimentary rock	Baynshire F.	Bayshin Tsav far SE	N43 25 06.5 E107 43 29.9
160819-05	8/19/2016	Volcanic sedimentary rock	Baynshire F.	Bayshin Tsav far SE	N43 25 13.2 E107 43 16.7
160819-06	8/19/2016	Sandstone	Baynshire F.	Bayshin Tsav far SE	N43 25 29.4 E107 40 26.7
160819-07	8/19/2016	Sandstone with Tuff	Baynshire F.	Bayshin Tsav far SE	N43 25 31.9 E107 40 28.4
160823-01	8/23/2016	Conglomerate	Nemegt F.	SharTsav	N43 34 15.1 E107 47 25.2
160823-02	8/23/2016	Sandstone	Baynshire F.	Amtgai. North	N43 36 00.9 E107 51 58.4
160823-03	8/23/2016	Sandstone (ESR)	Baynshire F.	Amtgai. North	N43 36 00.9 E107 51 58.4
160823-04	8/23/2016	Sandstone (ESR)	Baynshire F.	Amtgai. North	N43 36 00.9 E107 52 06.1
160823-05	8/23/2016	Sandstone (ESR)	Baynshire F.	Amtgai. North	N43 36 08.8 E107 52 50.9
160823-06	8/23/2016	Sandstone (ESR)	Baynshire F.	Amtgai. North	N43 36 10.57 E107 52 47.92
160823-07	8/23/2016	Sandstone (ESR)	Baynshire F.	Amtgai. North	N43 36 10.57 E107 52 47.92
160826-01	8/26/2016	Sandstone (ESR)	Baynshire F.	Bayshin Tsav	N43 29 46.08 E107 45 21.15
MA 160818-01	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 09.1 E107 45 05.6
MA 160818-02	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 11.3 E107 45 09.7
MA 160818-03	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 10.4 E107 45 11.8
MA 160818-04	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 10.2 E107 45 12.2
MA 160818-05	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 09.8 E107 45 13.9
MA 160818-06	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 13.4 E107 45 06.0
MA 160818-07	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 11.4 E107 45 05.8
MA 160818-08	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 11.3 E107 45 04.9
MA 160818-09	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 11.0 E107 45 04.7
MA 160818-10	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 11.0 E107 45 46.7
MA 160818-11	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 29 58.2 E107 45 14.2
MA 160818-12	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 30 04.0 E107 44 52.0
MA 160818-13	8/18/2016	SandStone	Baynshire F.	BayshinTsav	N43 29 45.8 E107 45 00.2
MA 160819-01	8/19/2016	SandStone	Baynshire F.	BayshinTsav	N43 29 59.1 E107 45 59.9

Geological survey was also executed.

4-3. Khoorai Tsav (Baynshirenian, Late Cretaceous)

The Khoorai Tsav locality is located about 3km south of Bayshin Tsav locality. Photographs of the locality are shown in Figure 4.

The following vertebrate fossils were discovered in the expedition of the year.

(1) Pelvic part of large hadrosauroid (in hard sandstone layer)

(2) Isolated bones of hadrosauroid (in bone bed)

These specimens were collected as 3 Plaster Jackets. Disarticulated fragmental bones were also collected as surface collection.

In the Khoorai Tsav locality, the Baynshire Formation is exposed. The lithology of this locality consists of sand dominated alternation of sandstone and mudstone. Bone beds including disartic-

ulated bones are often observed in this area. Paleoenvironment of this locality is fluvial. Geological survey and rock sampling were executed.

4-4. Shar Tsav (Nemegtian ?, Late Cretaceous)

The Shar Tsav locality is located about 9km north of Bayshin Tsav, about 108km ESE of Manlai Somon and about 70km north of Han Bogd Somon (South Gobi Aimag). The site is recognized as an important site of dinosaur footprints (Ishigaki et al. 2009). The Lithology of the footprint yielding locality consists of sand dominated alternation of white coarse sandstone and red muddy fine sandstone. The age of Shar Tsav locality is not clear. As *Avimimus* skeletons had been found in Shar Tsav West, tentatively, it is attributed as Nemegtian age (Watabe et al. 2006; Watabe et al. 2010). Photographs of the locality are shown in Figure 5.

The following footprints were discovered in the expedition of the year.

(1) 4 natural casts of very small theropod.

(2) 67 natural casts of small theropod (possibly Avimimus).

(3) 3 natural casts of mid-sized theropod.

All specimens were collected. At the site where 67 natural casts of Avimimus-type footprints had been found, almost all footprints direct westward. The evidence suggests the gregarious behavior of the animal. Geological survey and rock sampling were executed.

4-5. Shar Tsav West and Far West (Nemegtian ?, Late Cretaceous)

Shar Tsav West is located 2km west, and Shar Tsav Far West is located 8km west of Shar Tsav main footprint site. The lithology of western locality consists of the alternation of white coarse sandstone and red muddy fine sandstone (Figure 5 A). Many broken natural casts of footprints were found in the field. The track makers of the footprints are theropod, ornithopod and sauropod. Badly preserved large quadrupedal trackways consisting of broken natural casts are abundant. The age of Shar Tsav West and Shar Tsav Far West locality is not clear. As *Avimimus* skeketons had been found in Shar Tsav West, tentatively, it is attributed as Nemegtian age (Watabe et al. 2006; Watabe et al. 2010). In Shar Tsav Far West, thick mudstone developed, and it is covered with conglomerate at the top. In these two localities geological survey and rock sampling were executed.

4-6. Amtgai (Baynshirenian, Late Cretaceous)

The Amtgai locality is located about 14km ENE of Bayshin Tsav Locality.

The following vertebrate fossils were discovered in the expedition of the year.

(1) Humerus of hadrosauroid

(2) Metatarsal of large-sized hadrosauroid

(3) Sacrum of dinosaur (?theropod)

These specimens were collected as 3 plaster jackets. Disarticulated fragmental bones were also collected as surface collection.

4-7. Amtgai North (Baynshirenian, Late Cretaceous)

The Amtgai North locality is located about 7 km NNW of Amtgai locality and about 7km NE of the Shar Tsav footprint site.

The following vertebrate fossils were discovered in the expedition of the year.

(1) Partial bones of sauropod vertebra

(2) Partial bones of sauropod pelvic part

Those bones are fragmental and we covered them in the field. Disarticulated fragmental bones were also collected as surface collection.

Geological surveys and rock sampling were executed.

4-8. Urlibe Khuduk (Baynshirenian, Late Cretaceous)

The Urlibe Khuduk locality is located about 50km north of Han Bogd Somon (South Gobi Aimag) and 25 km W –WSW of Bayshin Tsav. Photographs of the locality are shown in Figure 6.

The following vertebrate fossils were discovered in the expedition of this year.

(1) One egg nest of dinosaur (possibly theropod) was discovered from the south part of the locality. 43-25-24.2N, 107-27-34.7E, 959.4mALT

(2) One partial skull of dinosaur

(3) One partial carapace of turtle

All specimens were collected as plaster jackets. Disarticulated fragmental bones were also collected as surface collection. Two footprints (natural cast) were found at the site 43-25-34.68N, 107-27-30.87E, 958mALT. Geological surveys and rock sampling were executed.

4-9. Two New Footprint Sites

Two dinosaur footprint sites were discovered by B. Mainbayar during his work for Shar Tsav natural heritage protection project in 2015-2016. OUS-IPG JE team confirmed that the findings are footprints, and performed ichnological investigation on the tracksites. The ages of these sites are not clear.

Site No.1: 43-31-07.5N, 107-43-55.7E, 904.5mALT. (2.7 km NW from Bayshin Tsav basecamp in 2016) The area is called Khavirgiin buuts by local people.

Four natural casts of sauropod footprints had been discovered at the hillside of the site. Two of these four casts are 106 cm in length and well preserved, but they do not belong to the same trackway. As the directions of two well preserved footprints are perpendicular to the hill surface, the trackway may continue to the inside of the hill (Figure 7A, C, and D). One trackway of large theropod consisting of 6 footprints was also discovered (43-31-06.5N, 107-44-00E) (Figure 7 E, and F). The lithology of the site is mud dominated alternation of white sandstone and reddish brown mudstone. There are many natural casts and natural cast-like hardened under layers (Figure 7 B) developed in the white hard sandstone layers in this

area (more than 50 footprints).

Site No.2: 43-31-47.5N, 107-43-09.7E, 921.9 ALT. (4.4 km NW of Bayshin Tsav basecamp in 2016)

One quadrupedal trackway (possibly sauropod dinosaur) consists of 6 natural casts of footprints is discovered (Figure 8 A, B).. Natural casts of theropod (FL:35cm) (Figure 8C) and ornithopod (FL:70cm) (Figure 8D) were also discovered. The lithology of the site is mud dominated alternation of white sandstone and yellow mudstone. The lithology is similar to that of the western part of the main footprint site of Shar Tsav. In both sites, ichnological research was executed.

4-10,11,12. Khongil Tsav, Burkhant, Baynshire (Baynshirenian, Late Cretaceous)

The geology team of OUS- IPG JE visited these sites during the trip from Ulanbaatar to Bayshin Tsav. Main purpose of the visit was geological reconnaissance and rock sampling. In addition, several fragmentary fossils of turtles including an adocid and a trionychid were collected from these sites. Photographs of the locality are shown in Figure 9.

5. Rock samples for age determination and stratigraphy

In order to constrain deposition ages of the Baynshire formation by using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) in Okayama University of Science, we have collected sandstone samples from the Bayshin Tsav, Shar Tsav, Amtgai North, Khongil Tsav, Burkhant, and Baynshire localities. Generally, sandstones contain a large amount of detrital zircons. It is known that zircon U-Pb analysis by means of LA-ICPMS can be useful to determine the maximum deposition age of the terrigenous clastics. Moreover, we have collected basalts, volcanic sediments and sandstones in Southeast part of the Bayshin Tsav locality. Based on the structural relations among them, the sandstone layer appeared to the lowermost part of the Baynshire formation. To verify this assumption, applications of K-Ar whole-rock and detrital zircon U-Pb analyses on collected samples would provide explicit data. These results would contribute to the comprehensive understanding of the geotectonic evolution of Mongolia and evolution of dinosaurs.

In addition, we also have collected rock samples in these areas for analyzing Cathodoluminescence (CL) characterization of quartz and Electron Spin Resonance (ESR) characterization of quartz. The collected samples are shown in Sample list file (Table 3) with GPS data.

6. Future perspectives

1) Dinosaur egg nest from the Urlibe Khuduk locality will give much information on morphology of eggshell, nesting processes, and dinosaur paleoecology in Baynshirenian age. Further prospection in the site would be also required.

2) Many partial bones collected during the expedition include some important specimens for investigating the evolution of hadrosauroid.

3) Newly found dinosaur footprint sites gave us valuable information for understanding dinosaur kinematics and their social behavior. Regarding the biggest footprint in the world, excavation of all trackways will reveal the locomotion of titanosaurid dinosaur.

4) The stratigraphic, radiometric and physicochemical data obtained from the rock samples would allow us to discuss the paleoenvironment and geotectonic evolution of the Gobi area in more detail.

Acknowledgments

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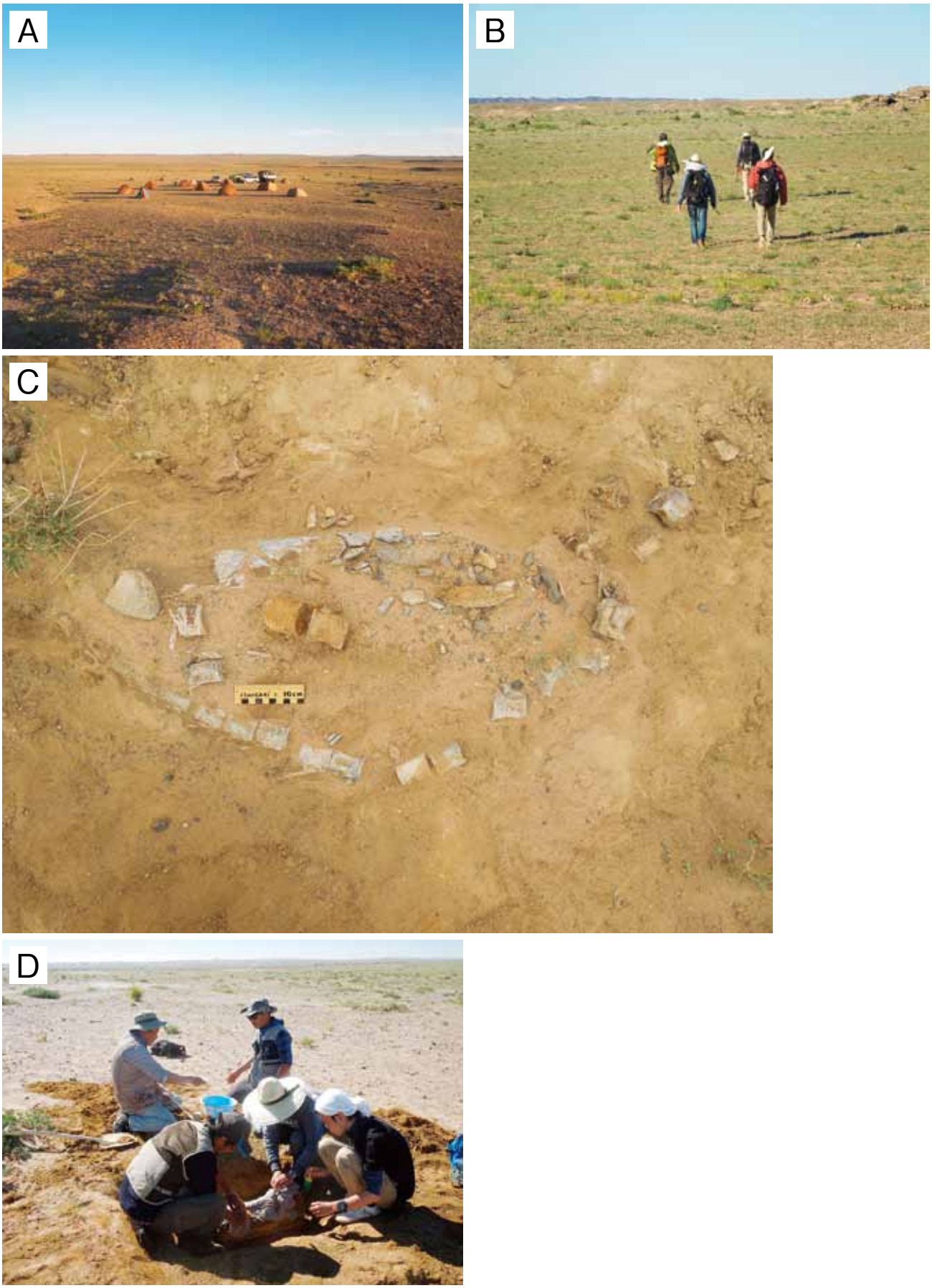

Figure 2. Bayshin Tsav locality, A; Base Camp in Bayshin Tsav. B; Fossil prospection in Bayshin Tsav IV. C; Caudal vertebrae and femur of hadrosauroid(?) found in Bayshin Tsav IV. D; Plaster jacket making in Bayshin Tsav IV..

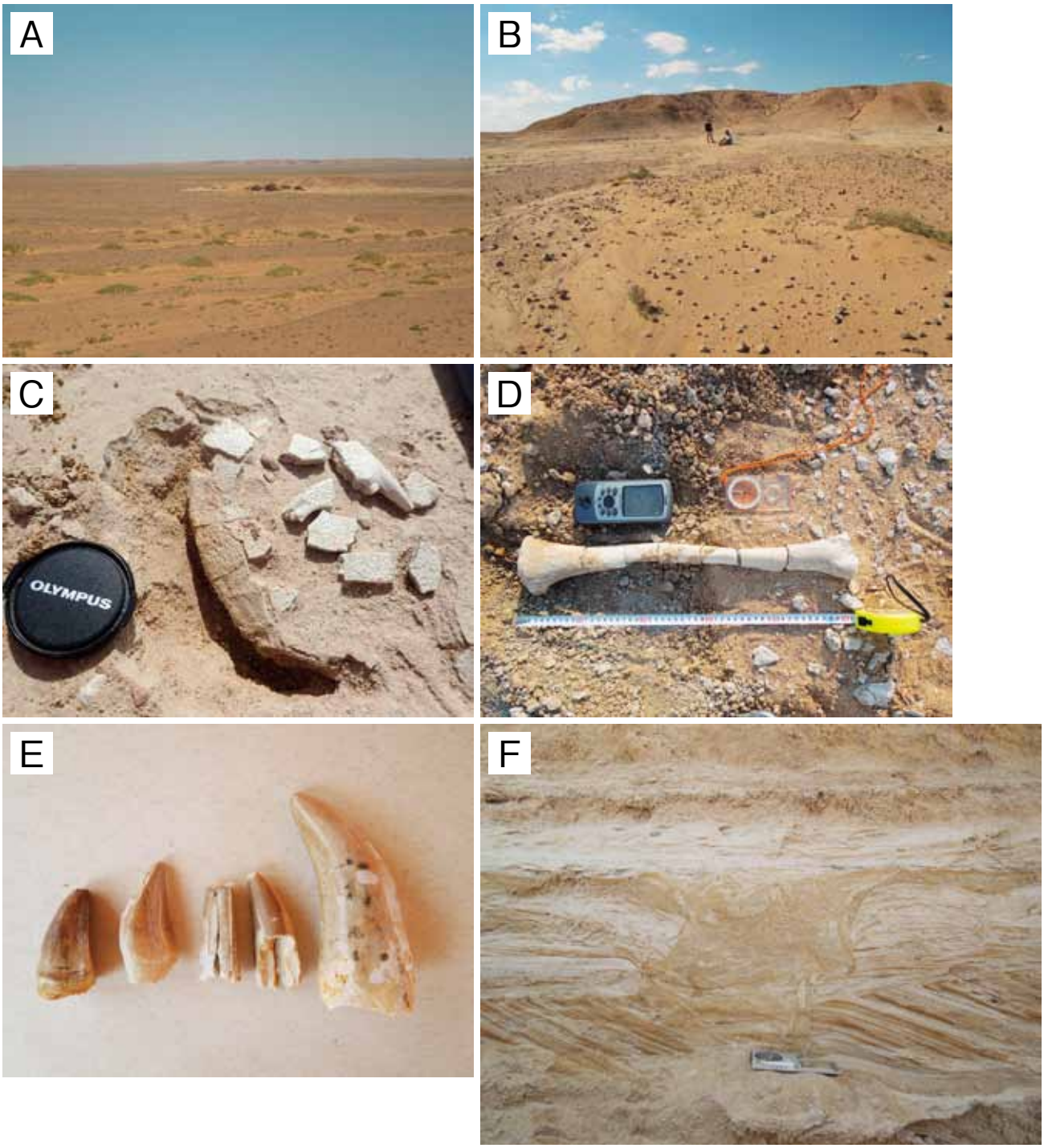

Figure 3. Bayshin Tsav West locality. A; Overview of the Bayshin Tsav West locality. B; Bonebed site. C; Turtle carapace. D; Fibula of hadrosauroid. E; Teeth of crocodile (left) and theropod (others). F; Cross section of dinosaur footprint in cross laminated fluvial sandstone. The clinometer for scale is 20 cm long.

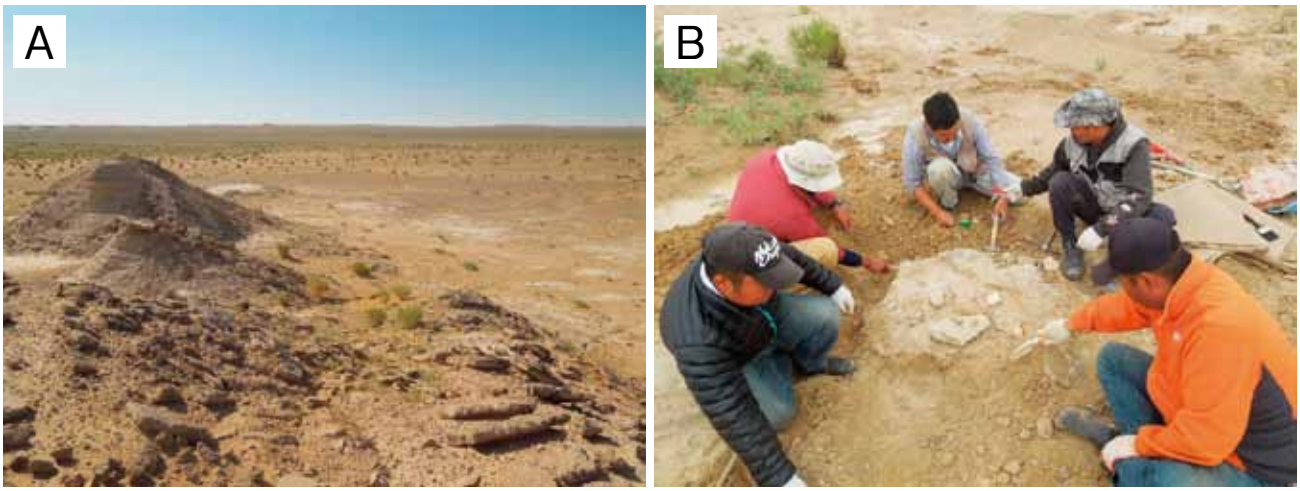

Figure 4. Khoorai Tsav locality. A; Overview of the Khoorai Tsav locality. B; Excavation of the pelvic part of hadrosauroid.

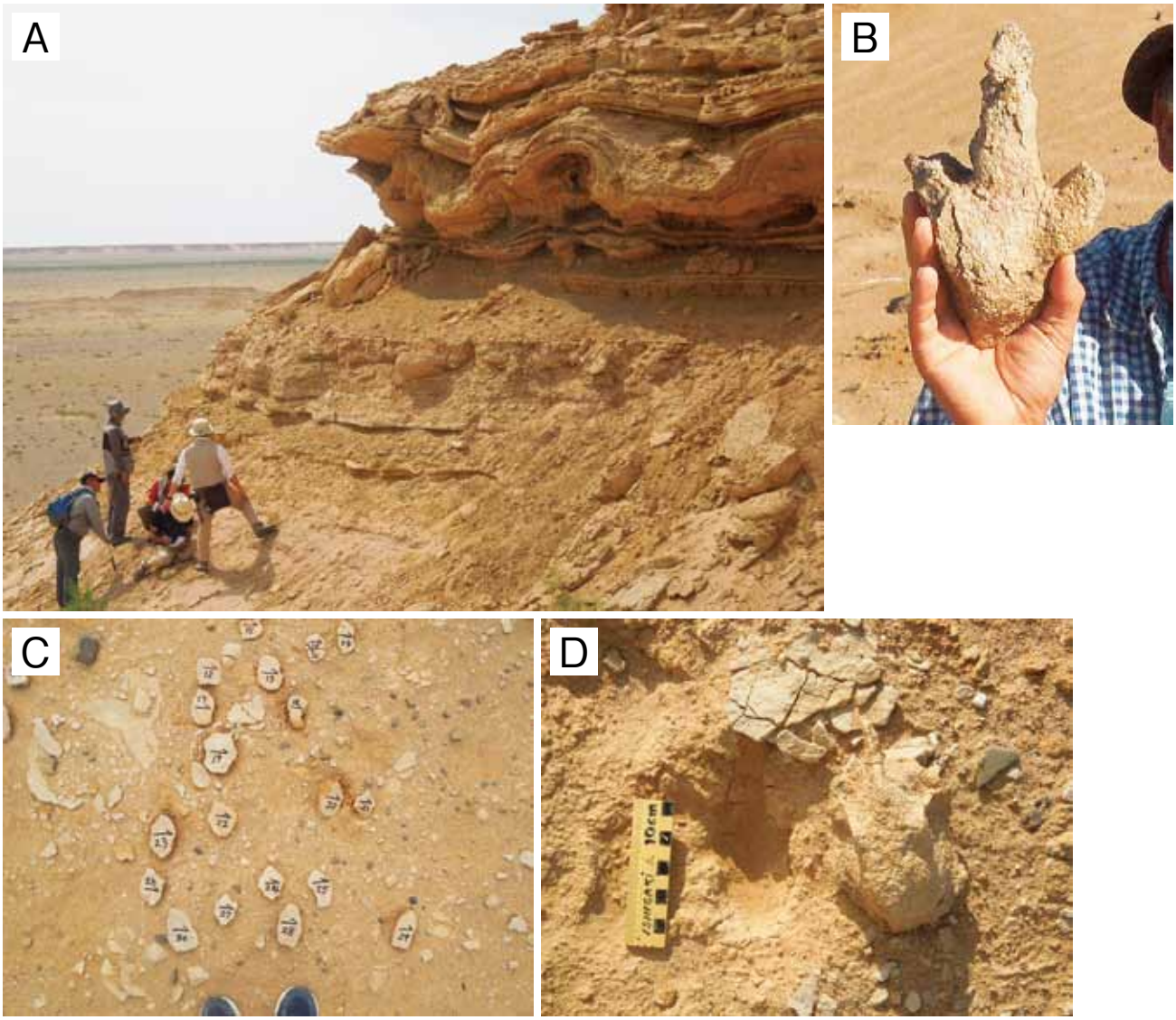

Figure 5. Shar Tsav locality. A; Landscape of Shar Tsav West locality. B; Natural cast of small theropod footprint. C; More than 20 natural casts of *Avimimus*-type footprints proving gregarious movement to westward. Arrows show north direction. D; Natural cast (right) and its original concave *Avimimus*-type footprint (left).

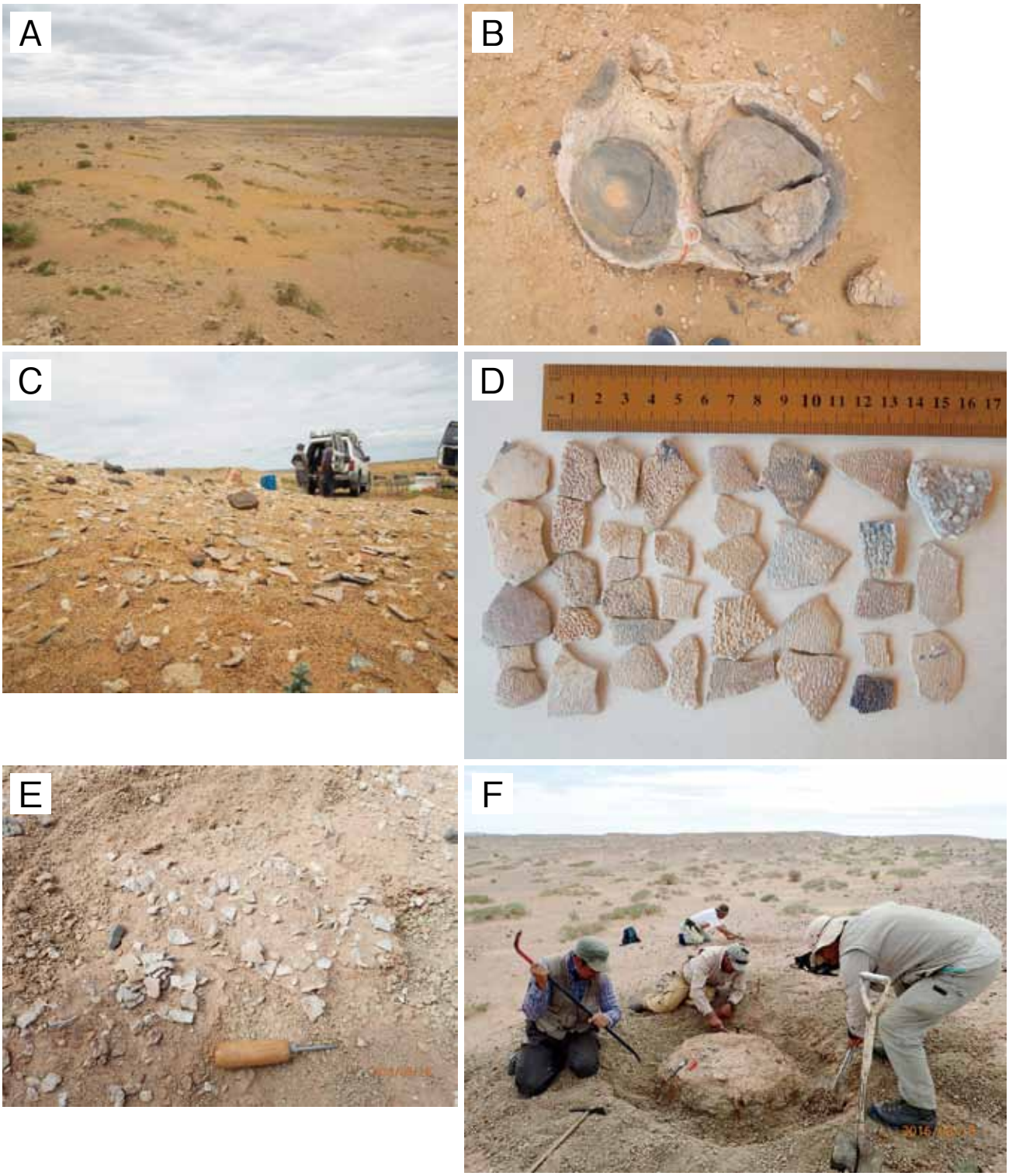

Figure 6. Urlibe Khuduk locality. A; Overview of the Urlibe Khuduk locality. B; Top view of two natural casts of dinosaur footprints. C; Eggshells scattered on the earth. D; Eggshells collected from the egg nest site. E; Egg nest. F; Excavation of the egg nest.

Figure 7. Newly found tracksite No.1. A; Overview of the tracksite in the hillside. B; Hardened Under layers (HUL) of footprints found in the tracksite C; Two large sauropod footprints and other weathered natural casts. D; Large sauropod footprint (natural cast) with clear claw marks I, II and III. E; Theropod trackway (natural cast). F; Theropod footprint (natural cast).

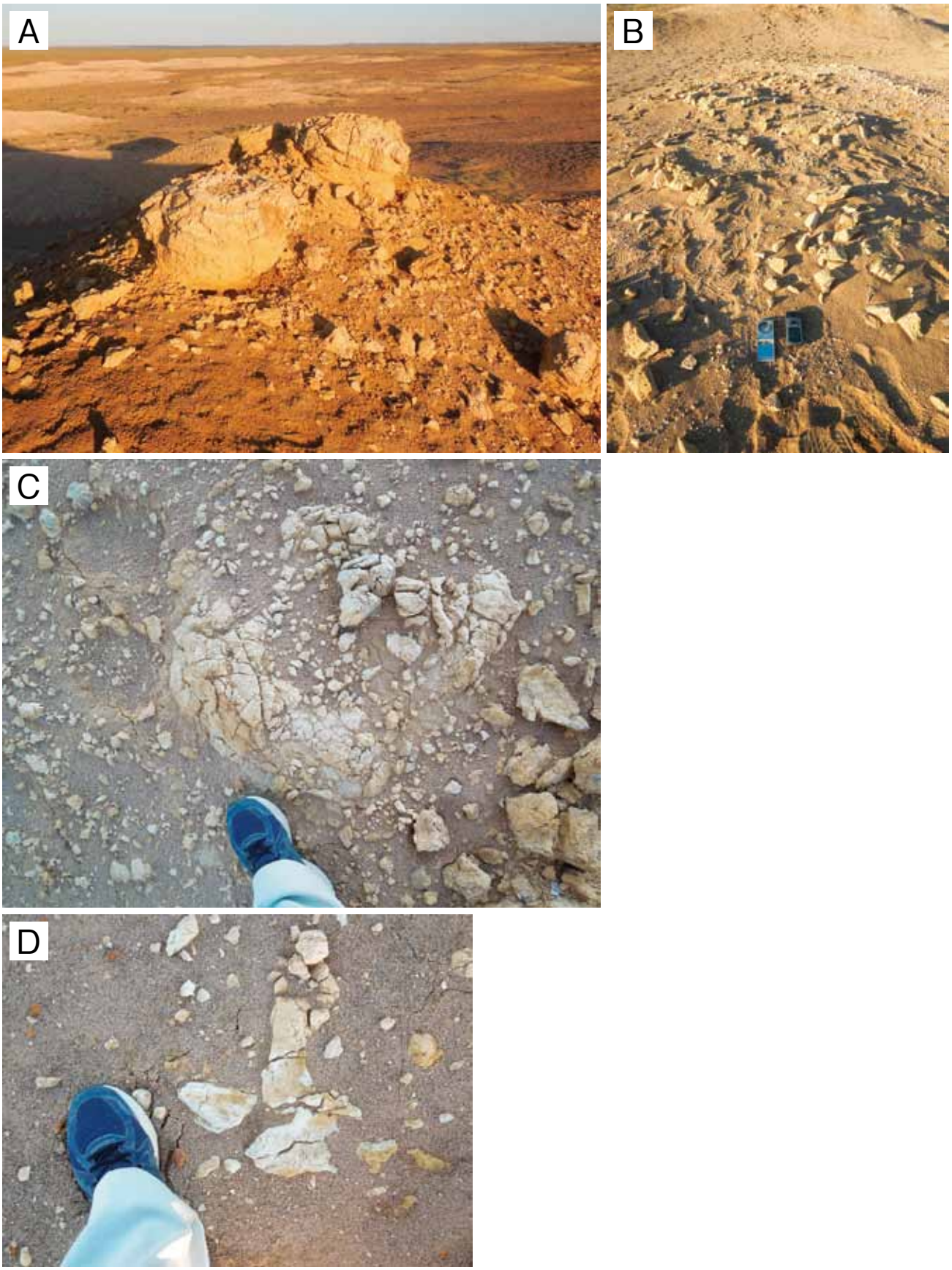

Figure 8. Newly found tracksite No.2. A; Two natural casts of dinosaur footprints and overview of the tracksite. B; Weathered quadrupedal trackway consisting of 6 natural casts. C; Weathered natural cast of large ornithopod footprint. D; Weathered natural cast of large theropod footprint.

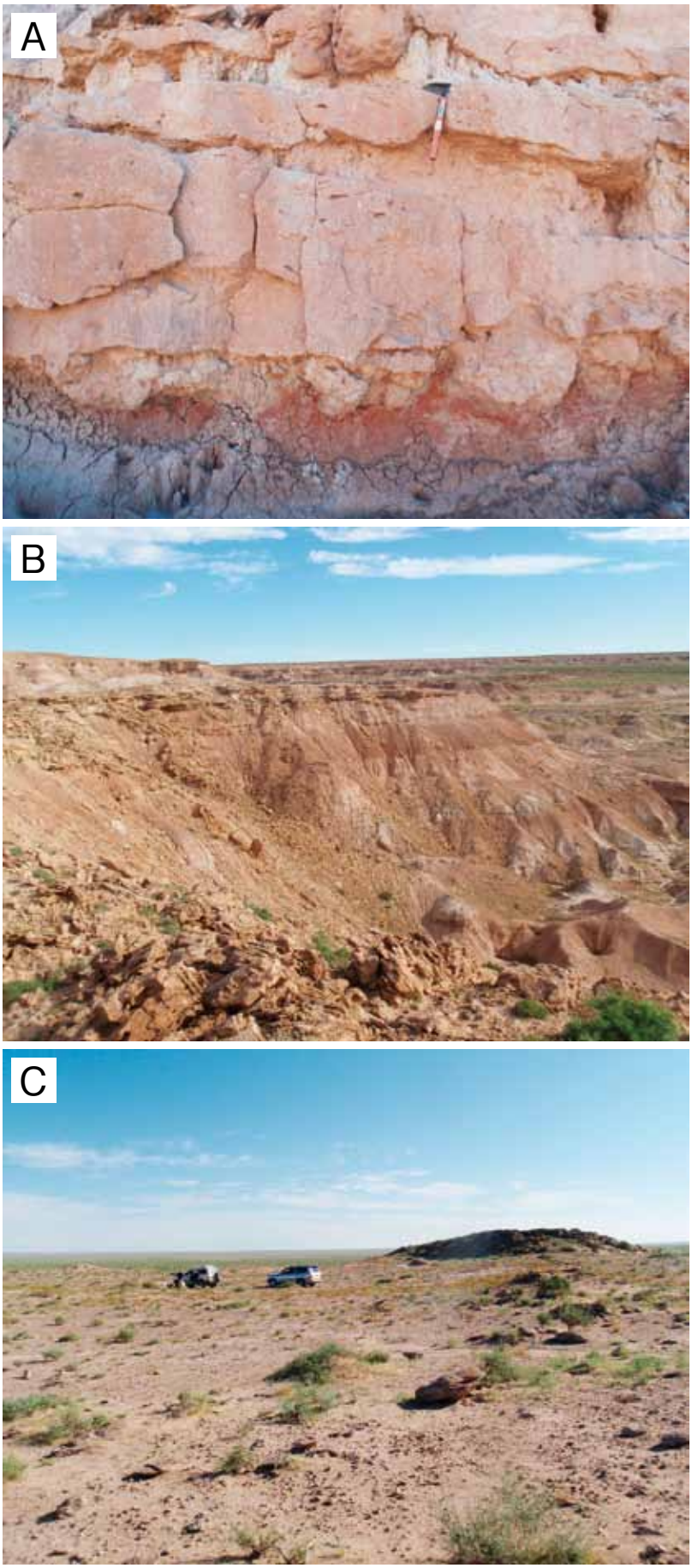

Figure 9. Eastern Gobi sites. A; Channel deposits in Khongil Tsav. B; Outcrop of Khongil Tsav. C; Outcrop of Burkhant.