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Urbanization and population on soil ecosystems of the river terraces

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Contents

Study in Japan

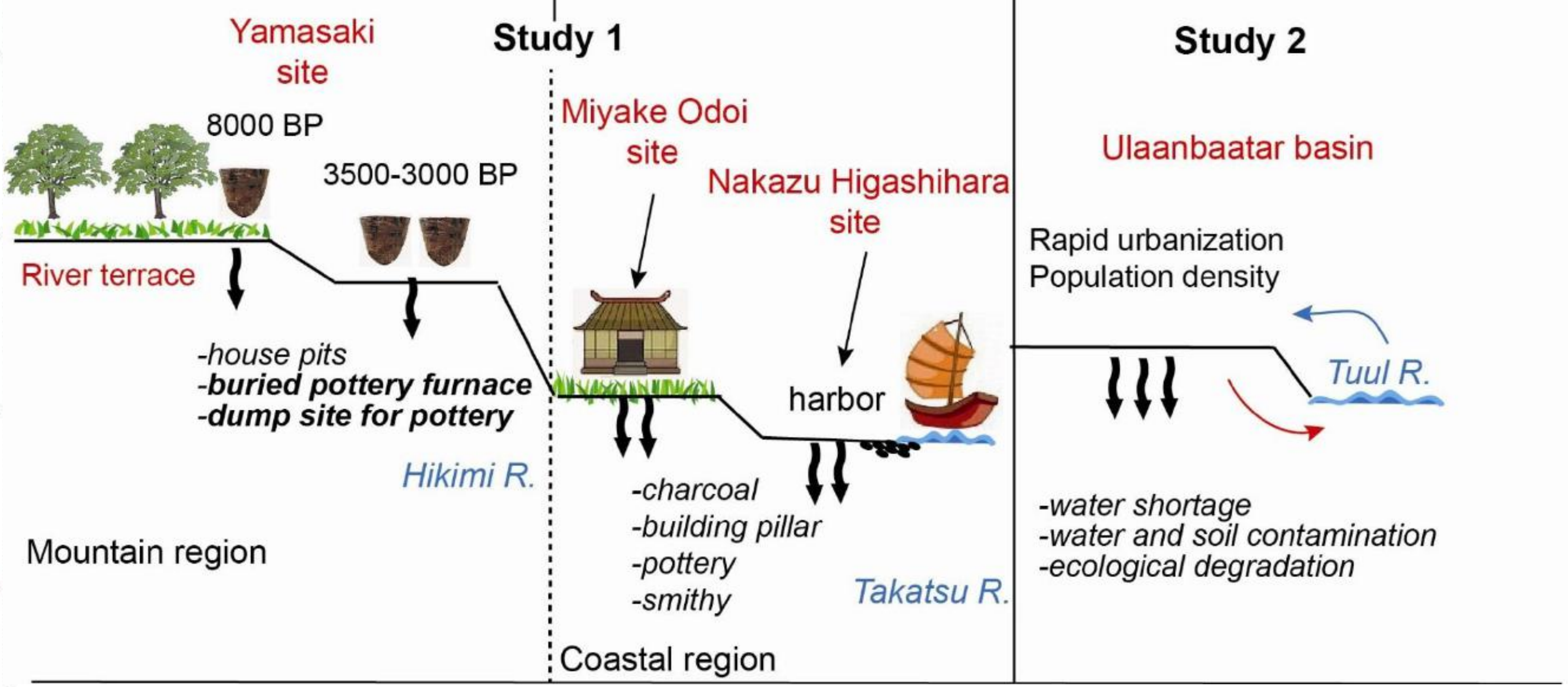
eochemical evaluation of soils at Jomon to Medieval archaeological sites in Masuda City.

Study in Mongolia

Geochemical evaluation of present-day Tuul River sediments in the Ulaanbaatar basin.

Summary of study

Ancient	Medieval	Present	*Period*
JAPAN Jomon ~ Yayoi (14.000-300 BP ~ 300 AD)	Muromachi ~ Kamakura (1185 AD ~ 1573 AD)	**MONGOLIA** 2010	
wood, nuts and fruits	charcoal and underground resources	petrol, coal and wood	***Resource***
hunting and gathering sedentary and semi sedentary rice agriculture and iron tools	blend of military and civilian art inspretion of economy port market with Asian countries	mining cattle breeding manufactory agriculture	***Life style***
2400 ~ (100 sites, Chugoku)	**6** million to **17** million (Japan)	**1** million (2009)	***Population***



Study 1

Introduction

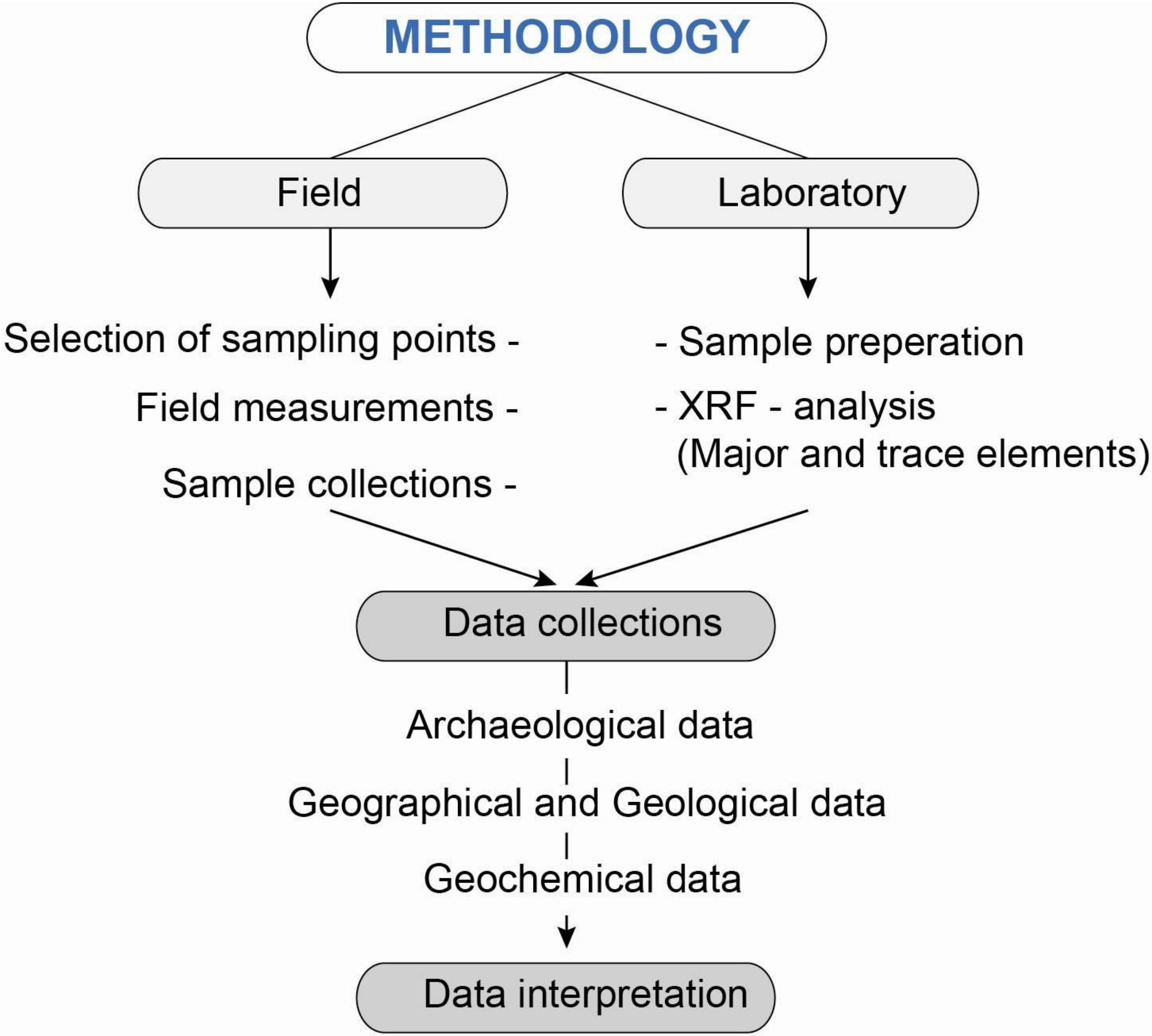
Archaeological studies at Masuda city:

- Artifacts, including burial mounds, stone tools, and pottery in different periods.
- Geochemistry of archaeological habitation soils may be altered due to deposition of ancient anthropogenic matter.
- Geochemical study provides an additional opportunity to identify past human activities and advance interpretation of this ancient settlement site.

Scope and objectives

- However, geochemical studies of soils have not been applied for this purpose in the area.

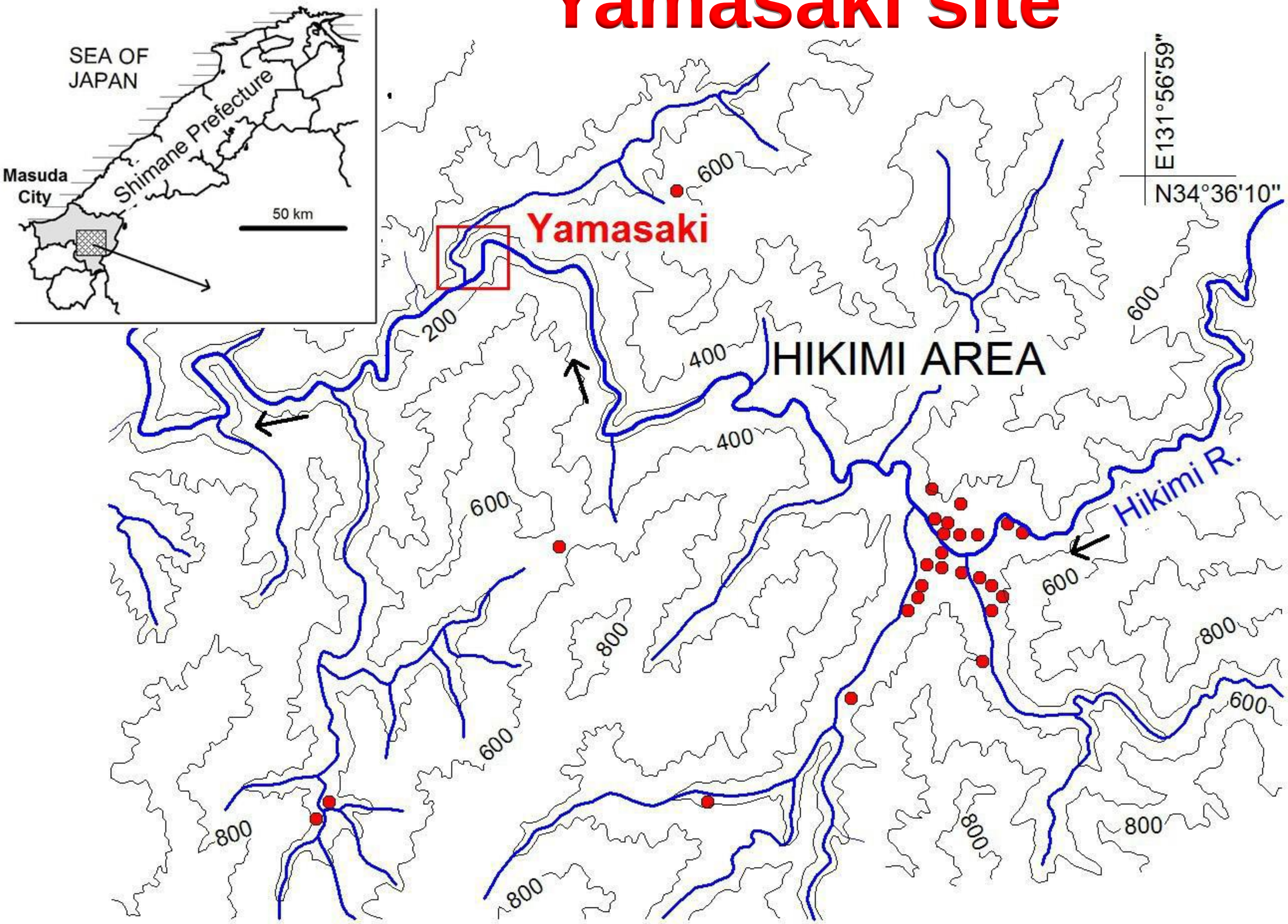
- The aim of our study is to assess the effect of past human activity on the soil chemistry, in an effort to reconstruct the human activities at the archaeological site.


METHODOLOGY
Field
Laboratory
Selection of sampling points -
Field measurements -
Sample collections -
- Sample preperation
- XRF - analysis
(Major and trace elements)
Data collections
Archaeological data
Geographical and Geological data
Geochemical data
Data interpretation

Study 1

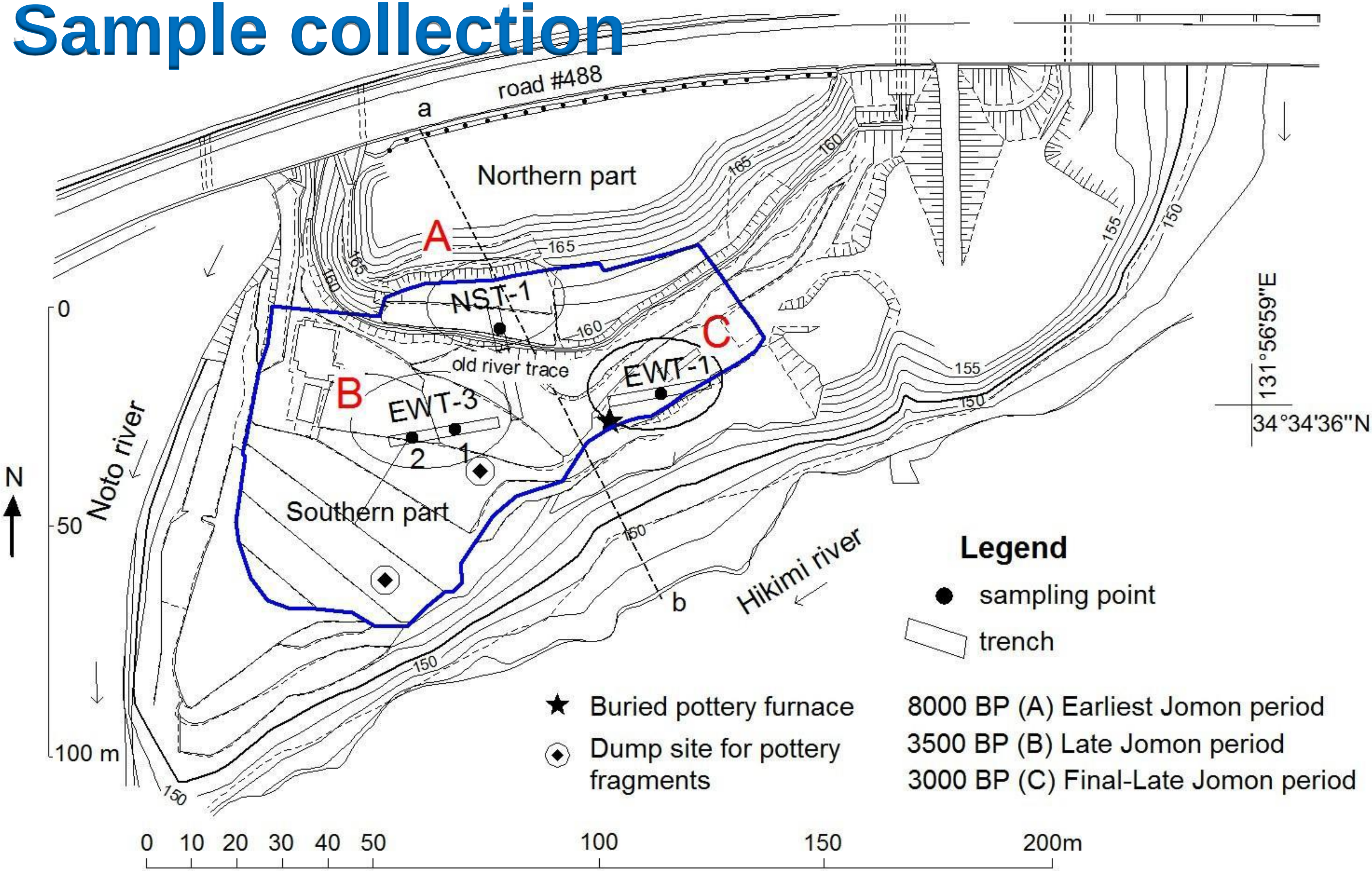
- Jomon settlement Yamasaki site (14.000-300 BP)
- Medieval harbor Nakazu Higashihara site (1200-1600 AD)
- Medieval settlement Miyake Odoi site (1200-1600 AD)

Yamasaki site



Archaeological sites the Hikimi district are mostly Jomon (14,500-300 BP) in age. Younger Yayoi (300 BC-300 AD) ruins and other remains overlie the Jomon horizon (*Editorial Board of Hikimi town. 2007*).

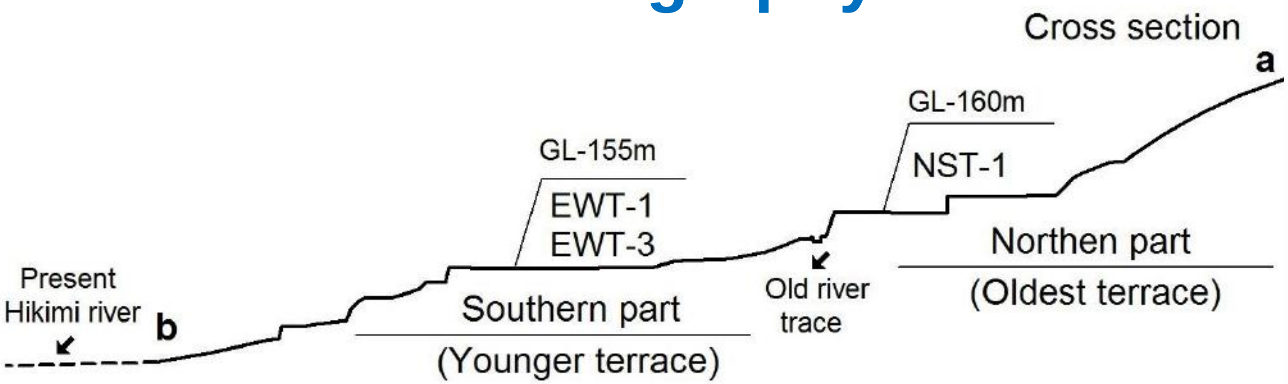
Sample collection



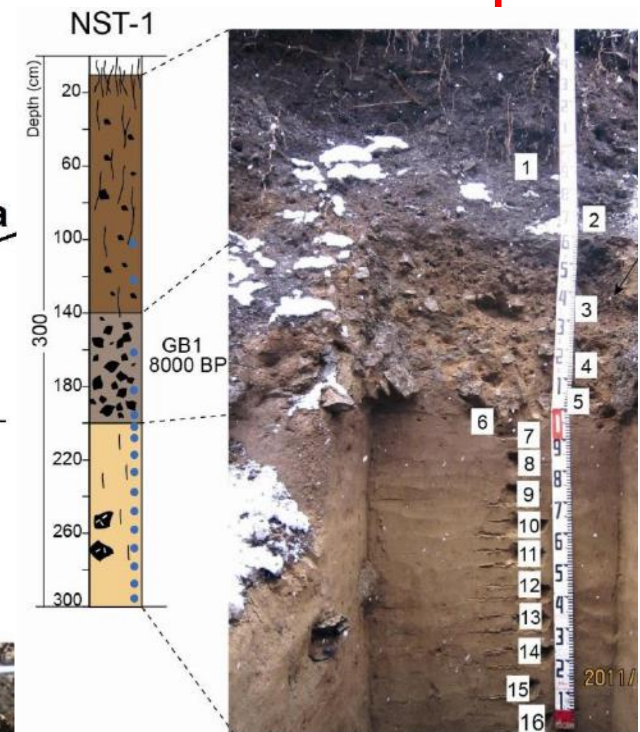
The present archaeological survey site at Yamasaki has an area of about 5700 m^2. The site was divided into three areas (A, B and C), according to the age of the unearthed artifacts.

Results and Discussion

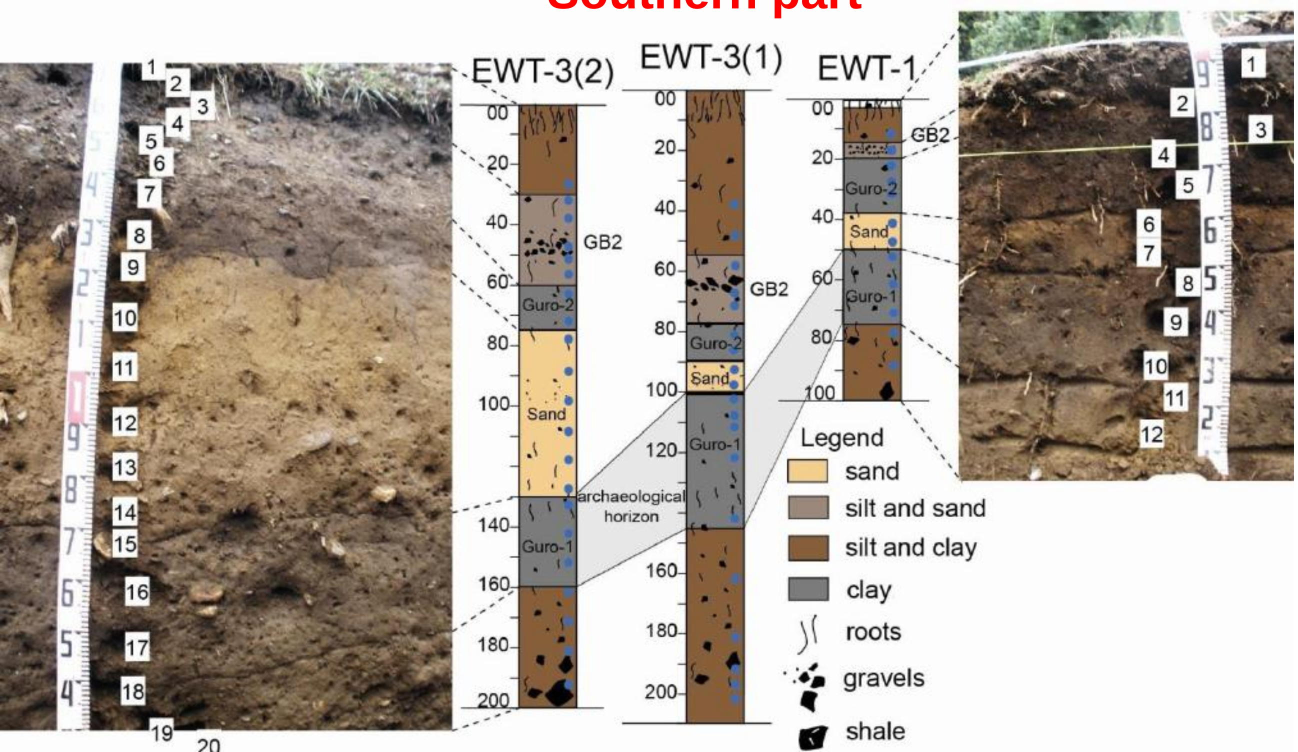
Soil stratigraphy



Northern part



Southern part



- ➢EWT-1 and EWT-3 developed under the **same environmental conditions**
- ➢ all are **younger** than the base of NST-1

Elements	Northern part		Southern part		UCC
	NST-1(n=16)		EWT (n=52)		
	Mean	Range	Mean	Range	Mean
TiO_2	0.51	0.39-0.74	0.53	0.42-0.64	0.64
Fe_2O_3	5.67	4.64-8.52	6.44	4.71-10.81	5.04
MnO	0.18	0.11-0.32	0.26	0.10-0.52	0.1
CaO	0.91	0.86-0.97	0.95	0.86-1.09	3.59
P_2O_5	0.13	0.06-0.38	0.22	0.14-0.36	0.15
As	34	28-42	47	29-122	5
Pb	57	41-120	84	39-271	17
Zn	121	92-163	326	170-448	67
Cu	24	17-33	37	23-50	28
Ni	20	8-40	27	11-42	47
Cr	35	18-71	43	23-102	92
V	82	49-168	96	59-128	97
Sr	71	53-78	66	58-81	320
Y	34	30-39	31	26-36	21
Nb	12	11-13	11	10-12	12
Zr	155	141-171	136	114-164	193
Th	14	12-18	12	10-14	11
Sc	10	6-18	9	5-13	14
F	68	2-222	114	9-315	557
Br	8	1-25	9	2-28	2
I	20	10-42	20	3-43	1
TS	353	247-609	492	293-1013	621

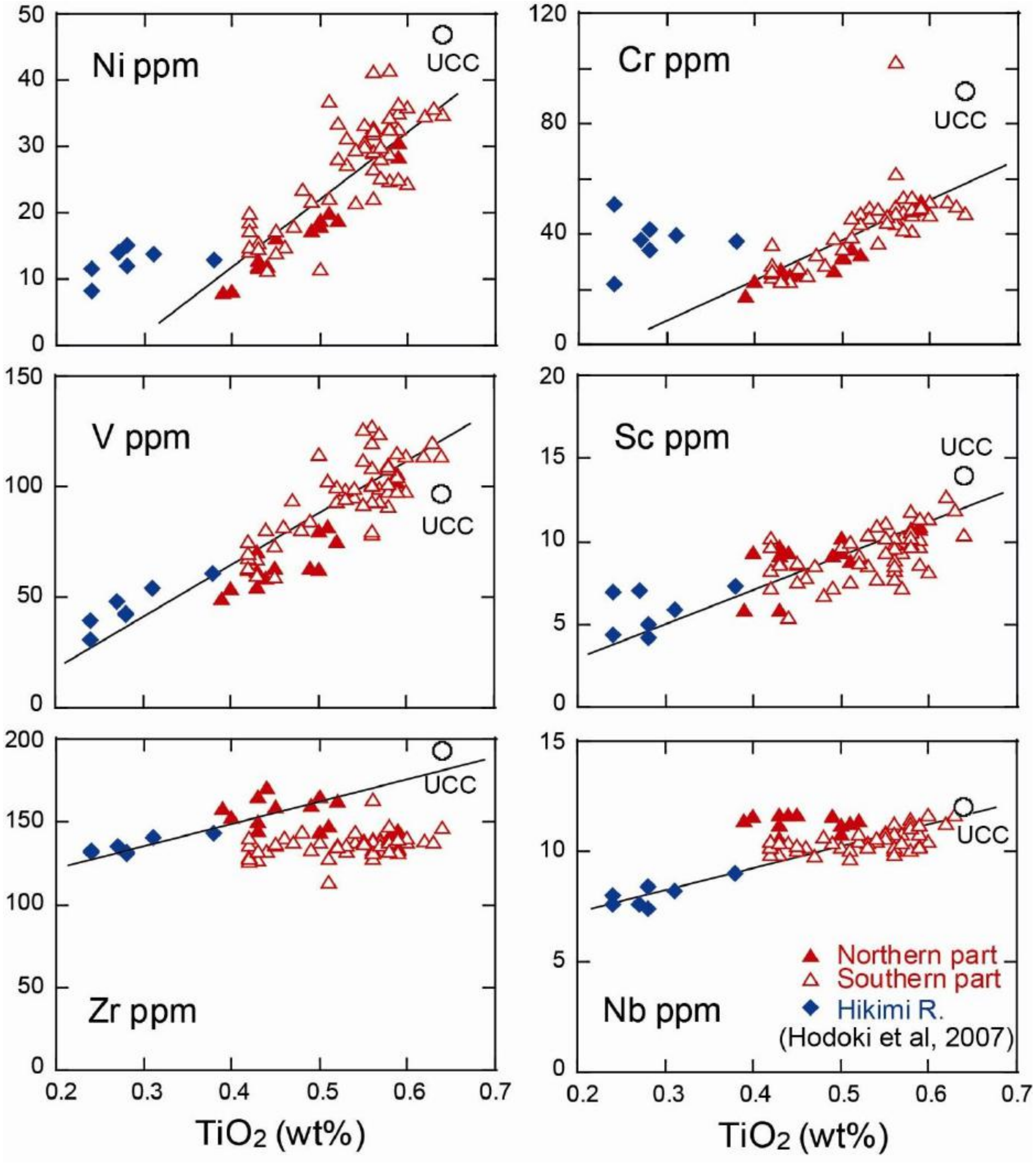
Geochemical characteristics

Geochemical compositions differ between the northern and southern parts.

- Most elements exhibited **higher values** in the southern part
- Some elements **do not differ** between the two parts.

Ti, Ca, Sr, Y, Nb, Zr, Th, Sc, Br, I

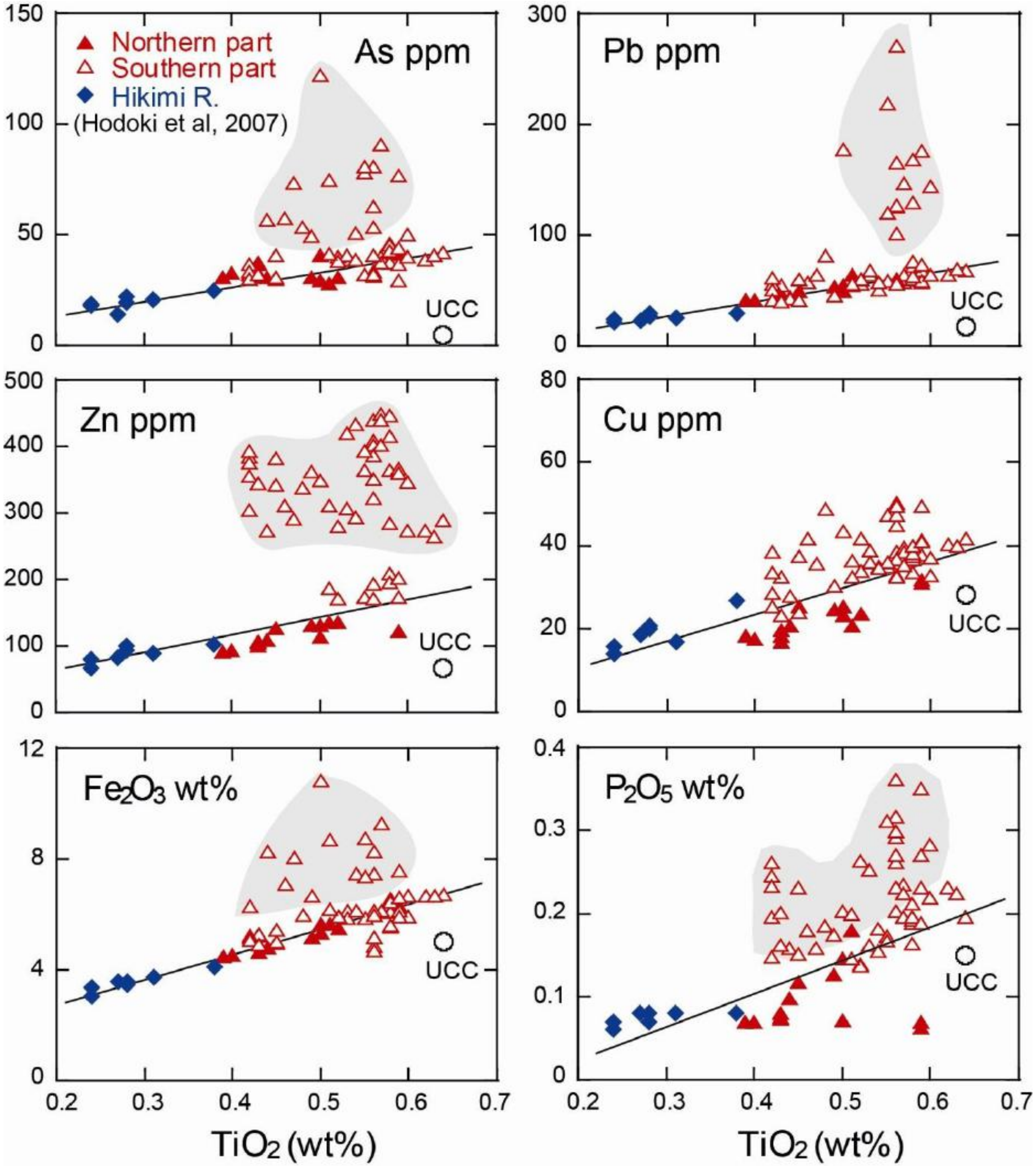
- Most elements are depleted relative to **UCC**



Anthropogenic or Detrital influence

Elements that show strong correlation with ***TiO_2*** *should only reflect natural detrital inputs.*

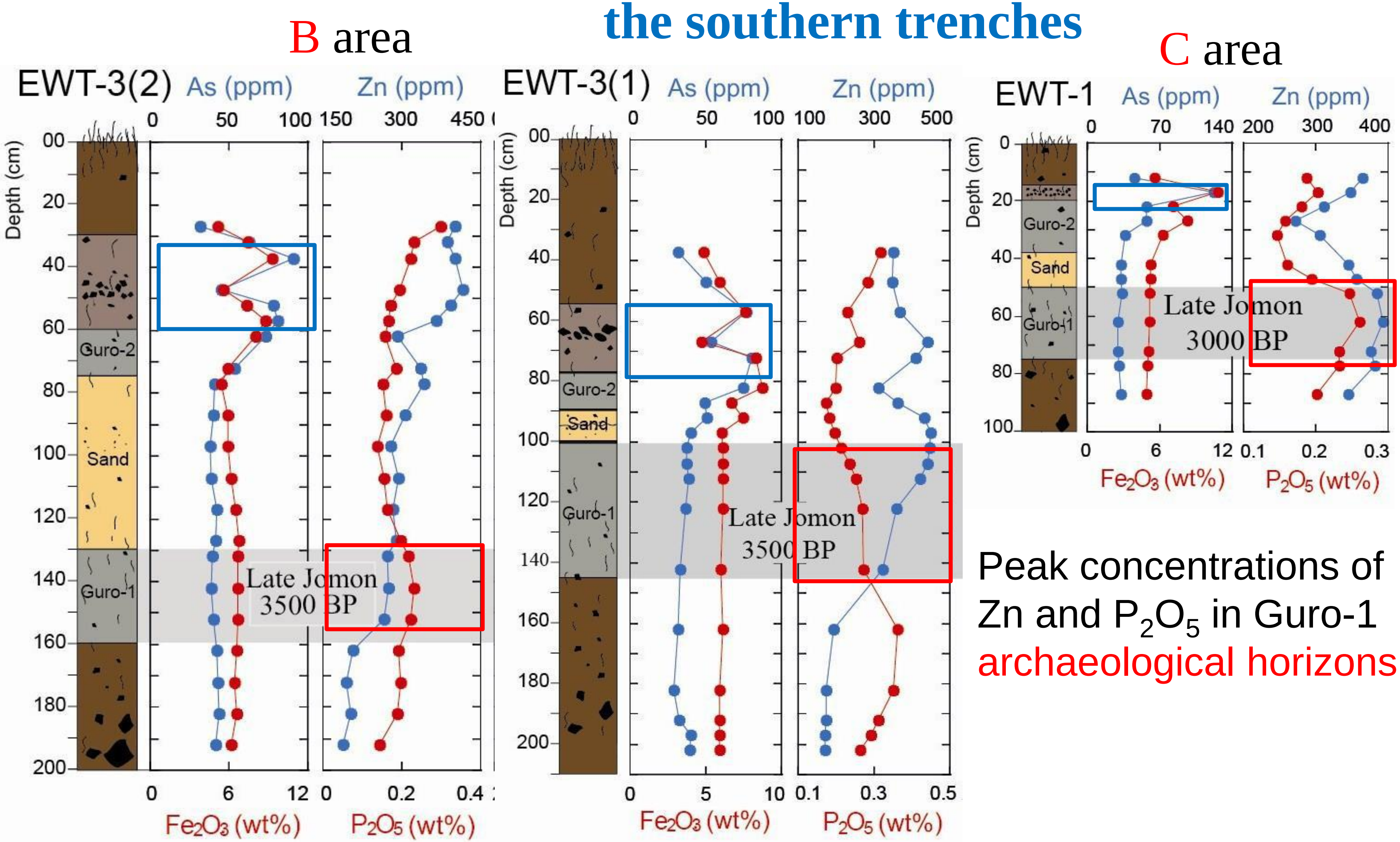
- Ni, Cr, V, Sc and immobile Zr and Nb show linear trends
- concentrated in clay minerals
- mainly of natural origin



Negative or weak positive correlations exist between TiO_2 and As, Pb, Zn, Cu, Fe and P

- Samples from the southern part show considerable scatter
- Enriched relative to detrital background
- Anthropogenic or pedogenic factors could be responsible

Vertical distributions of elements in the southern trenches



Peak concentrations of Zn and P_2O_5 in Guro-1 archaeological horizons

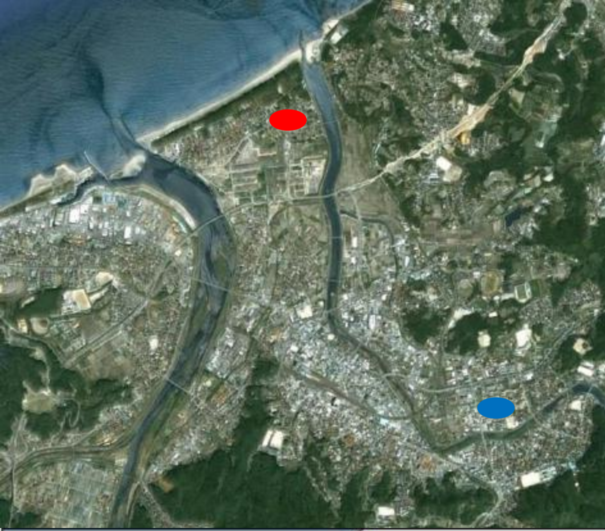
High concentrations of As and Fe occurred in the same horizons (Gravel bed) that contains abundant of oxidized clasts and are precipitated in oxidizing conditions (*Bibi at al. 2008*).

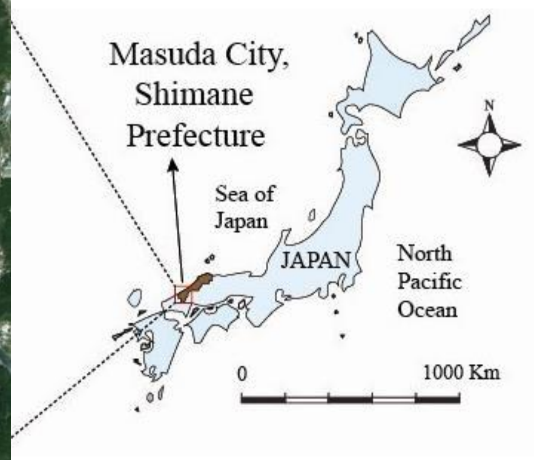
Archaeological excavation
at the Yamasaki site, 2011

Conclusions

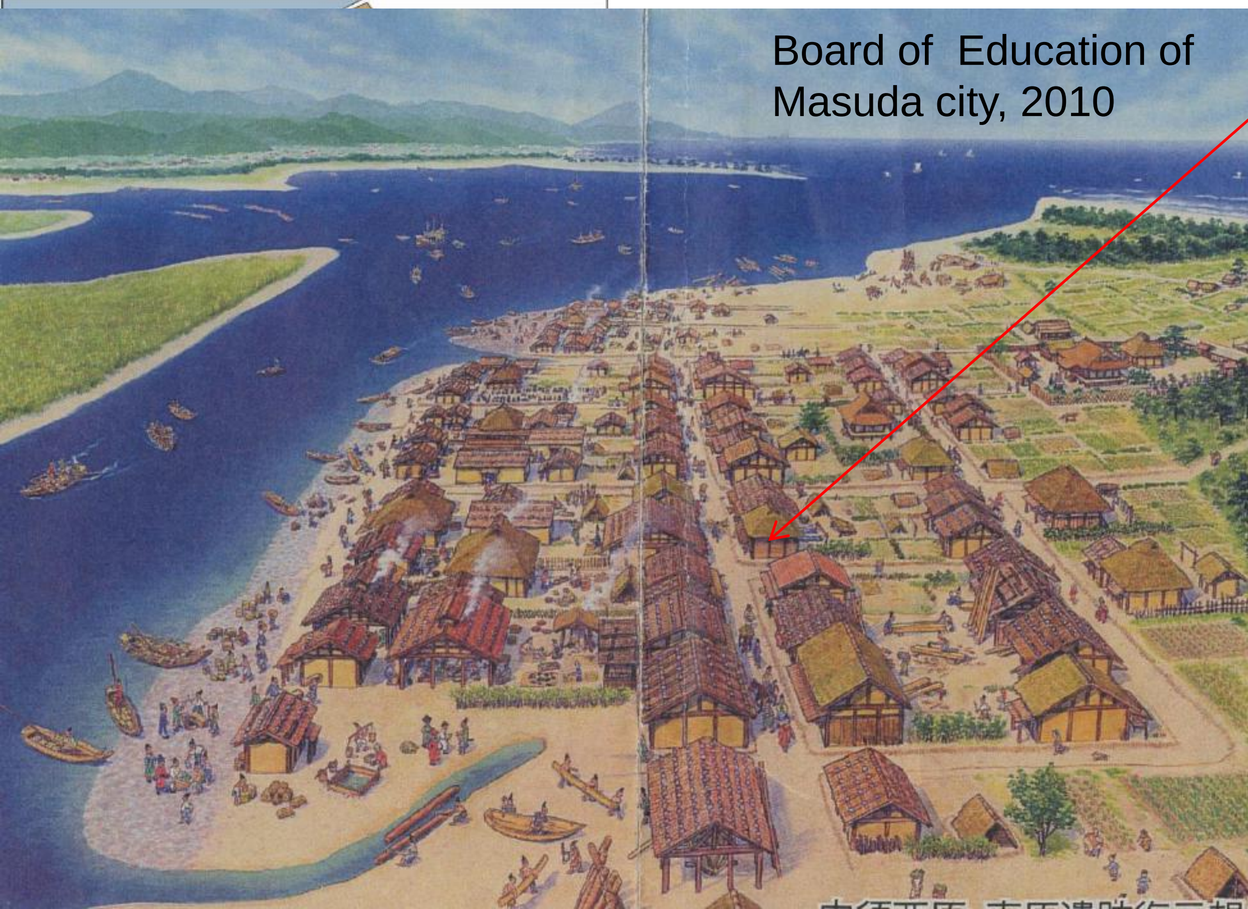
- Peak concentrations of As and Fe_2O_3 occur at the same depth in the oxidized horizon (GB), associated with adsorption on or precipitation of iron oxyhydroxides.

- Enrichments of Zn and P_2O_5 in the archaeological horizon seem to be related to anthropogenic effects, such as habitation and firing pottery using wood as a fuel.

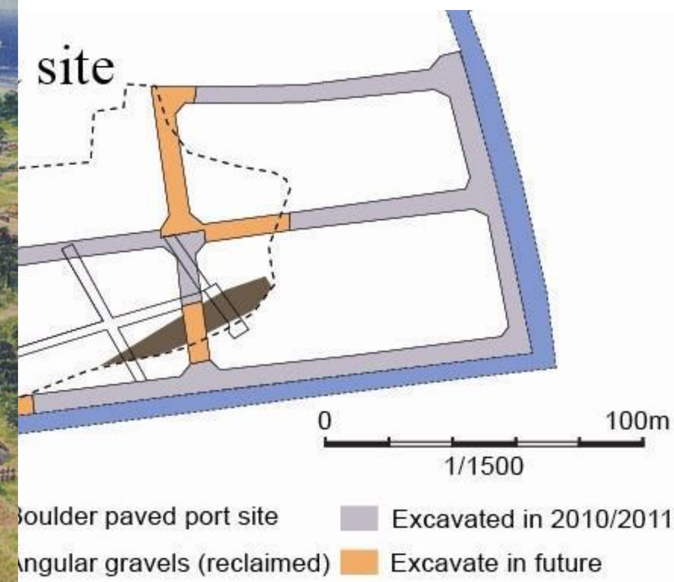




Nakazu Higashihara site

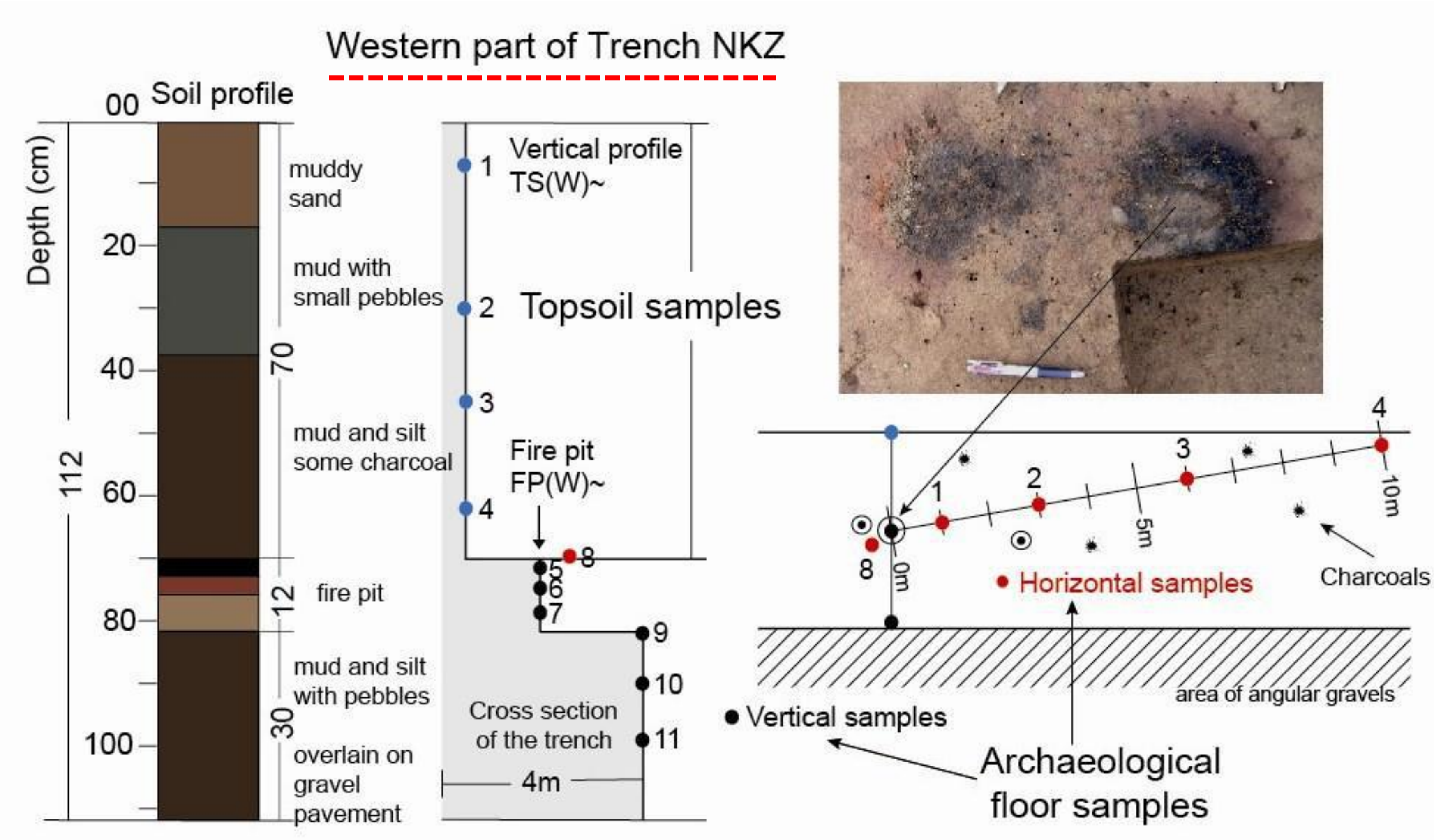


Board of Education of Masuda city, 2010



d Higashihara sites have
Prefecture, Japan.

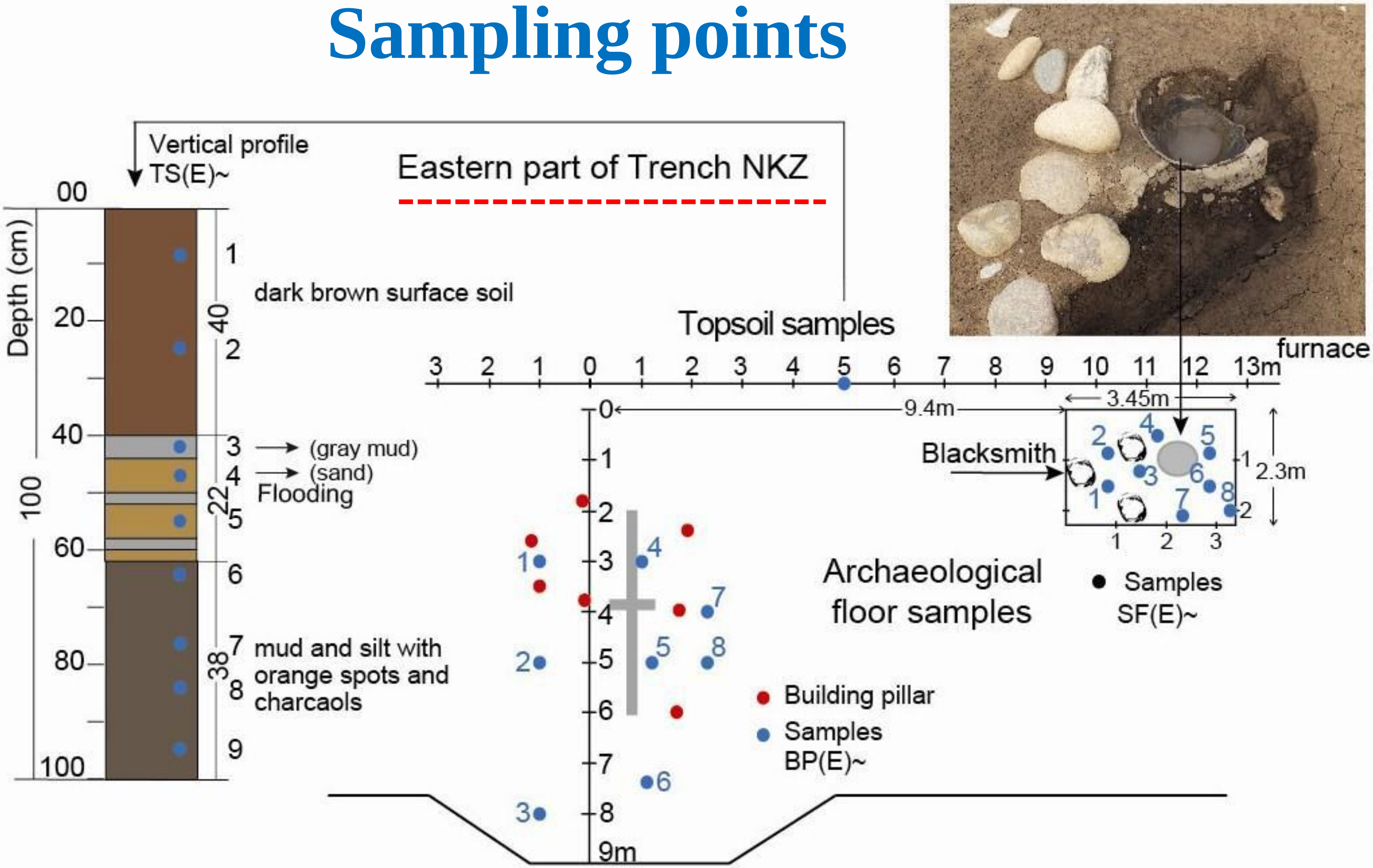
Sampling points



The soil samples were divided into:

- **topsoil** samples (deposited after prehistoric occupation)
- **archaeological floor** samples (prehistoric occupation)

Sampling points

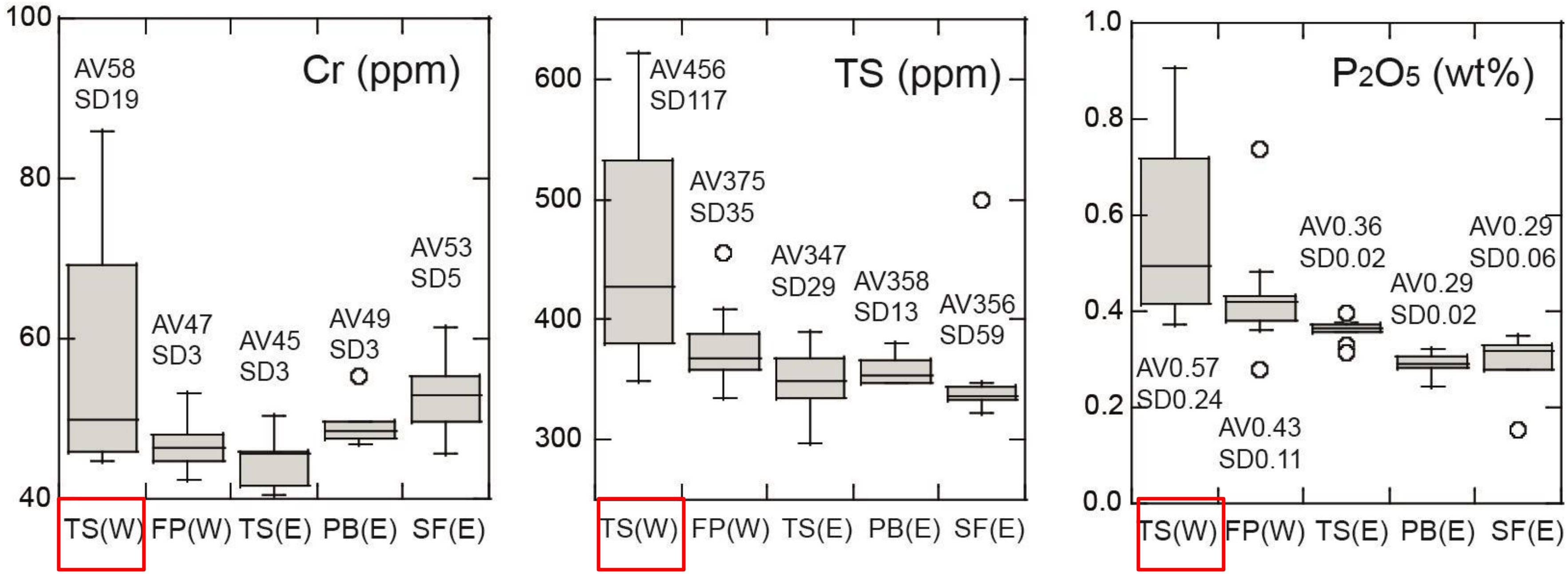


Two areas with differing activity were recognized in the Eastern part.

8 samples - area of post holes from building pillars

8 samples - area of blacksmith furnaces.

Results and discussion

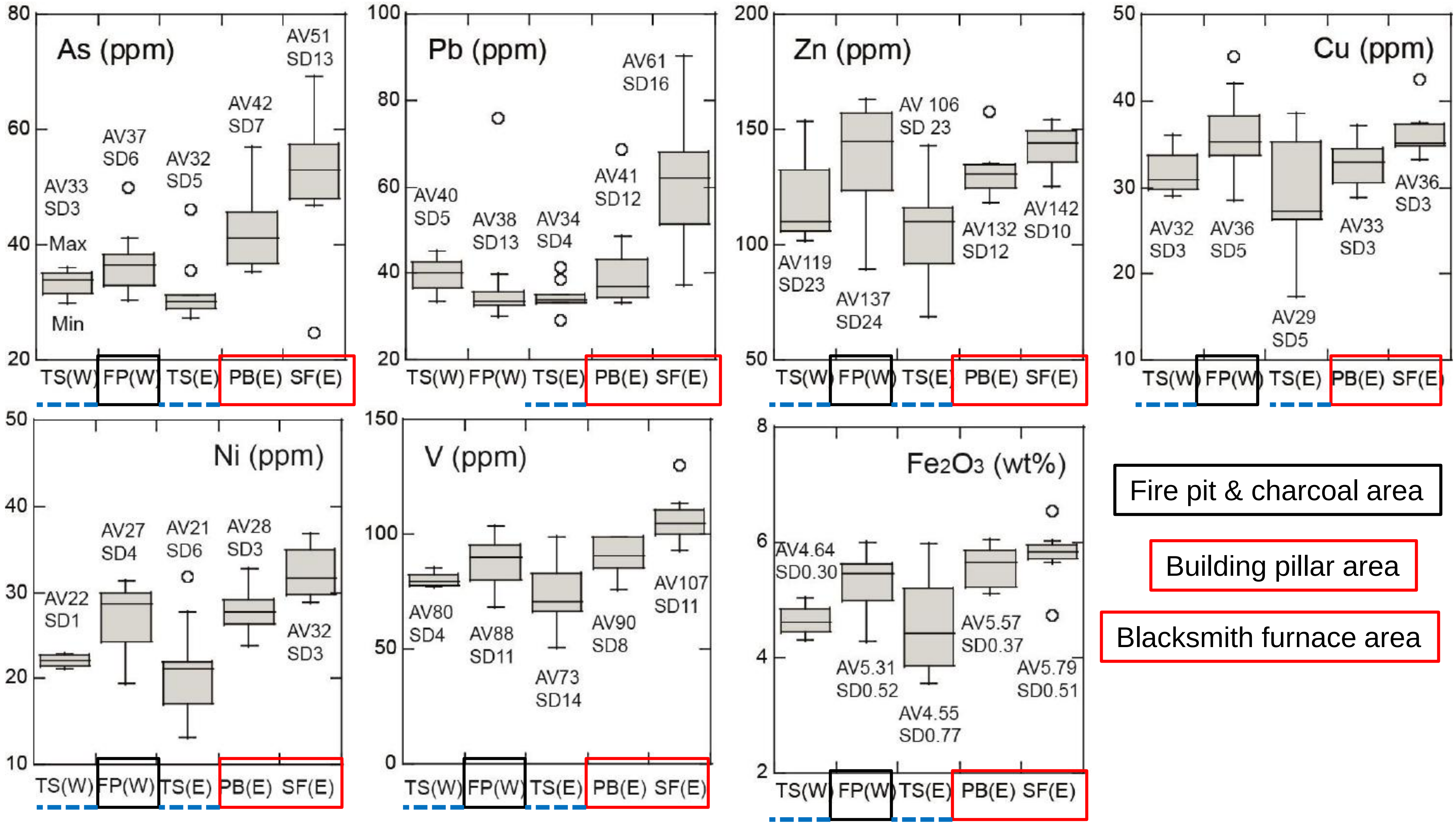


The geochemical characteristics of the topsoils and archaeological floor samples in the Nakazu Higashihara site showed some contrasts.

Topsoil samples in the Western part are characterized by highest values of Cr, TS and P.

- ➢ deposition of modern anthropogenic matter

Results and discussion

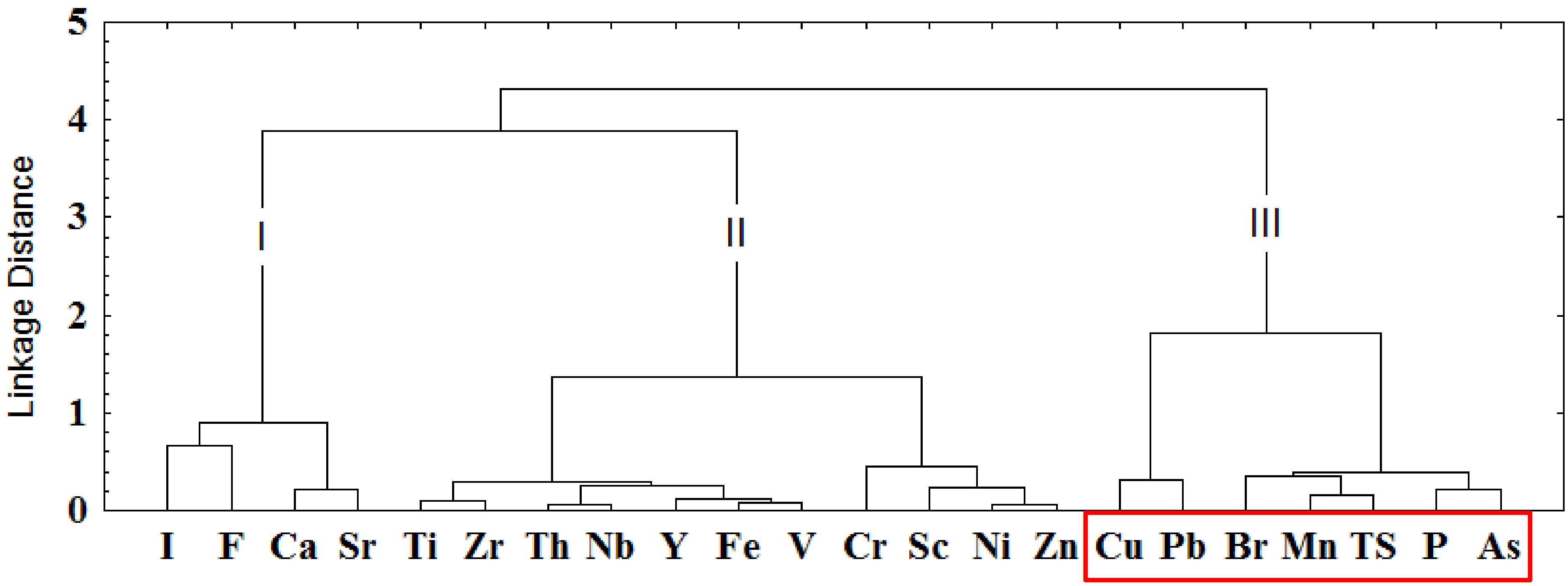


As, Pb, Zn, Cu, Ni, V and Fe were higher in archaeological floor samples

- ancient anthropogenic effects

Inter-element relationships in three activity areas

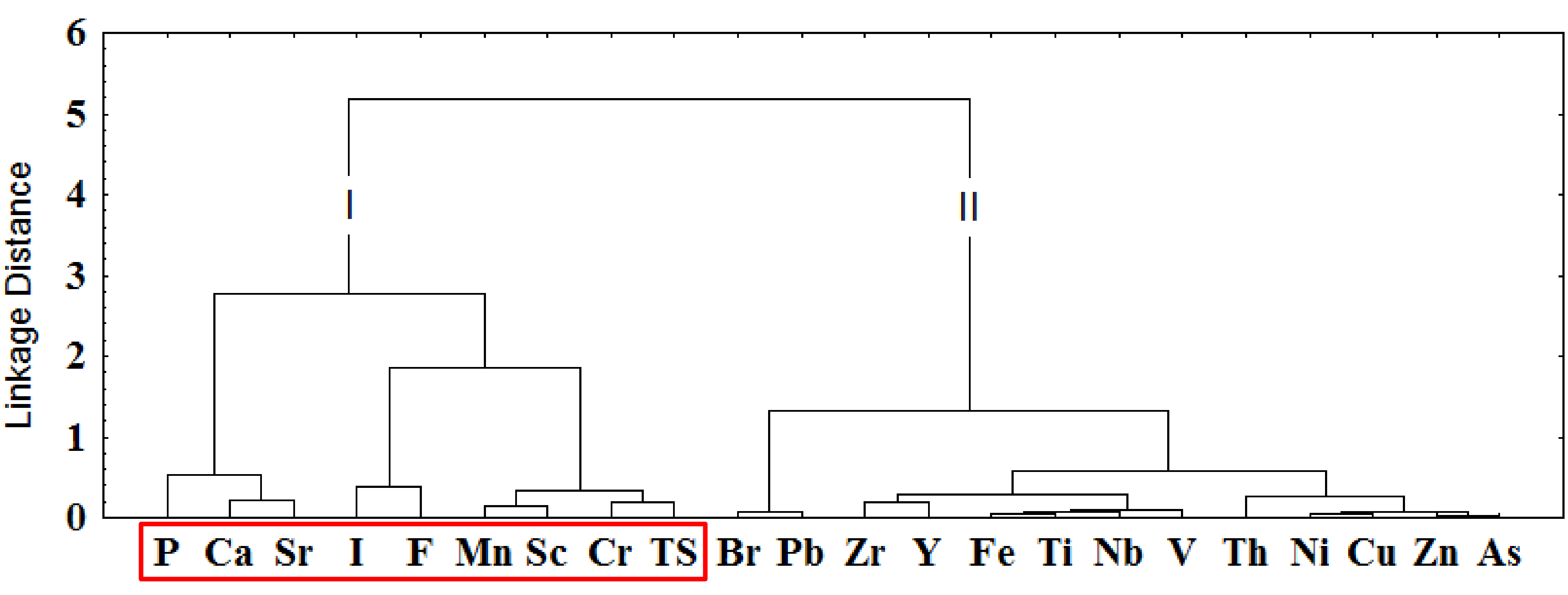
Fire pit and charcoal area FP(W)



Group I: consisted of I, F, Ca and Sr
Group II: Ti, Zr, Th, Nb, Y, Fe, V, Cr, Sc, Ni, and Zn } natural source

Group III: Cu, Pb, Br, Mn, TS, P and As are elevated in archaeological floor samples. → firing and heating

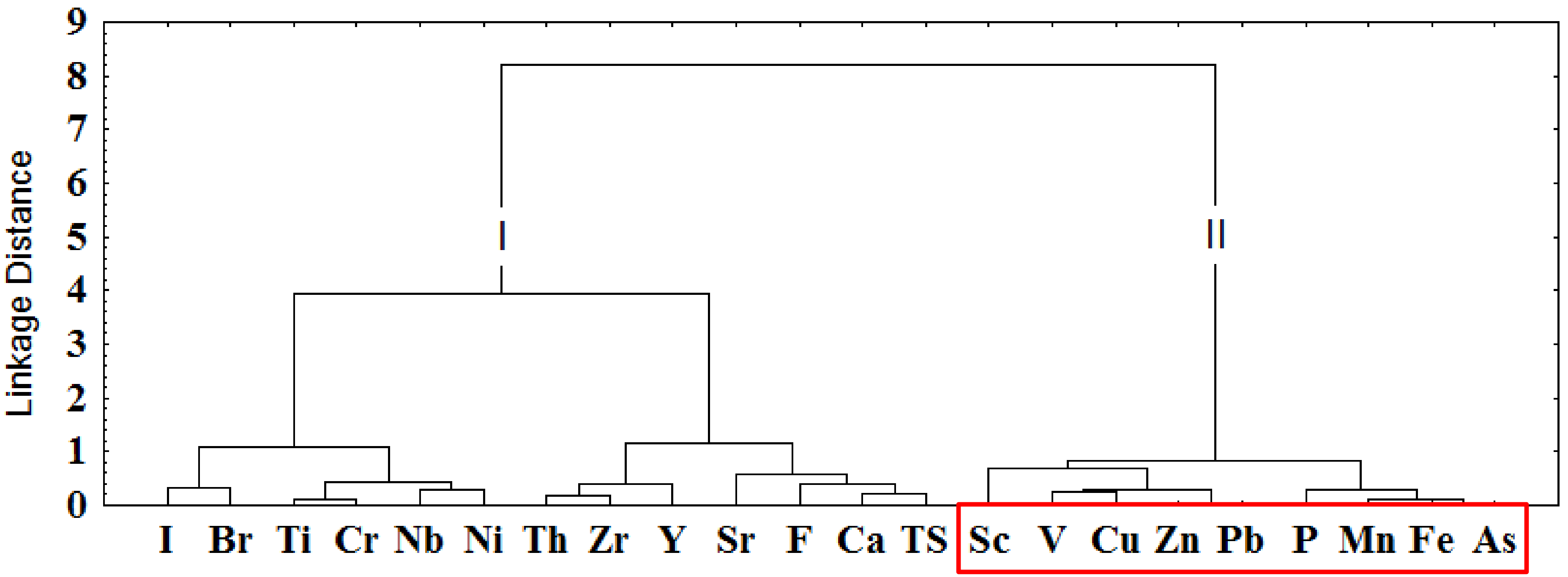
Building pillar area BP(W)



Generally, P, Ca and Sr are associated with organic waste disposal in activity areas (*Middleton and Price, 1996*)

- Group I elements reflected similarity in source associated with deposition of residential wastes.

Blacksmith furnace area SF(E)



Group I: no apparent enrichment.

Group II: highest concentrations in this area (except P in topsoil).

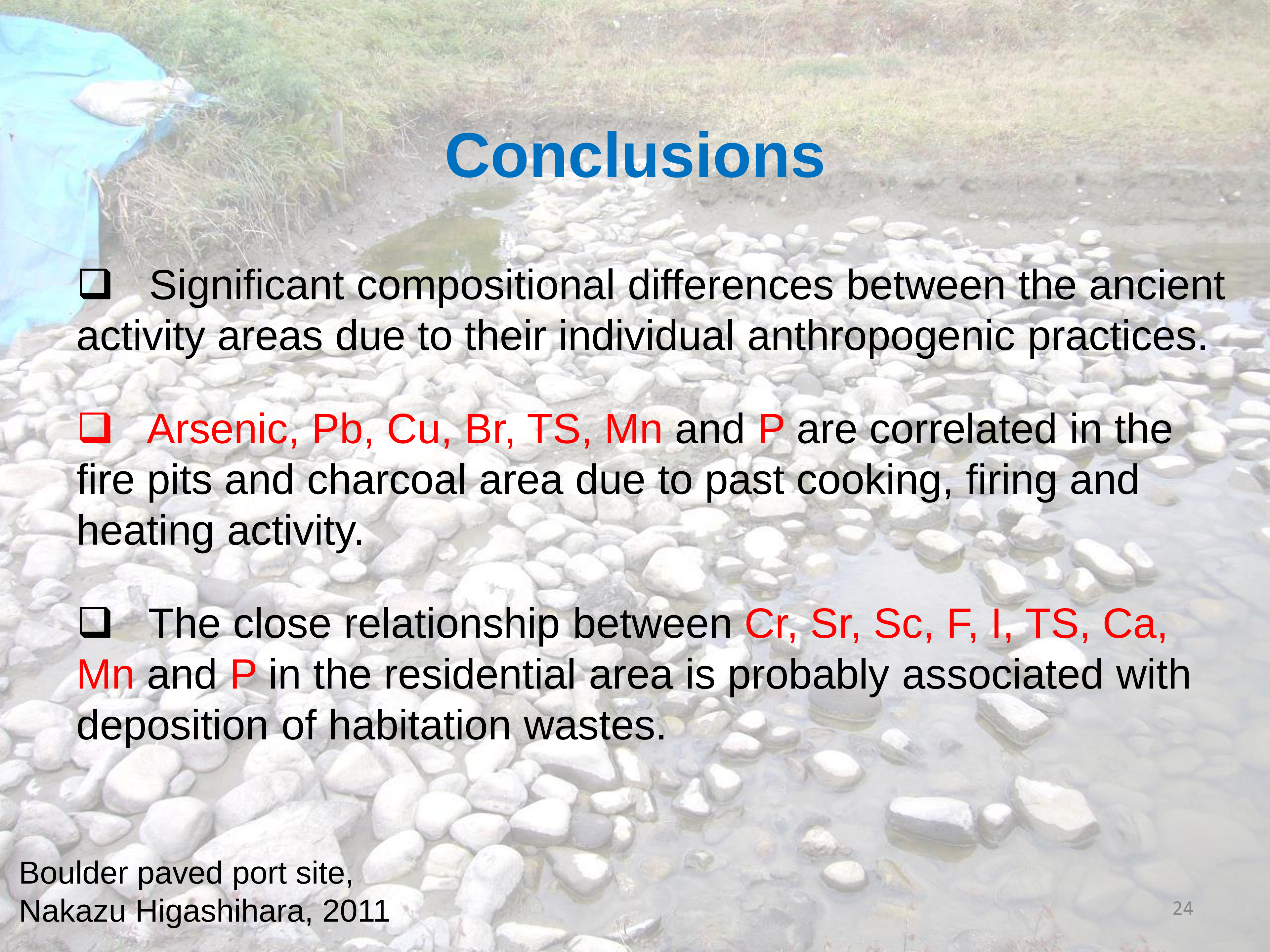
- long linkage distance indicated sources were different
- anthropogenic effects, such as metallurgical activity at the harbor

Conclusions

- Significant compositional differences between the ancient activity areas due to their individual anthropogenic practices.

- Arsenic, Pb, Cu, Br, TS, Mn and P are correlated in the fire pits and charcoal area due to past cooking, firing and heating activity.

- The close relationship between Cr, Sr, Sc, F, I, TS, Ca, Mn and P in the residential area is probably associated with deposition of habitation wastes.



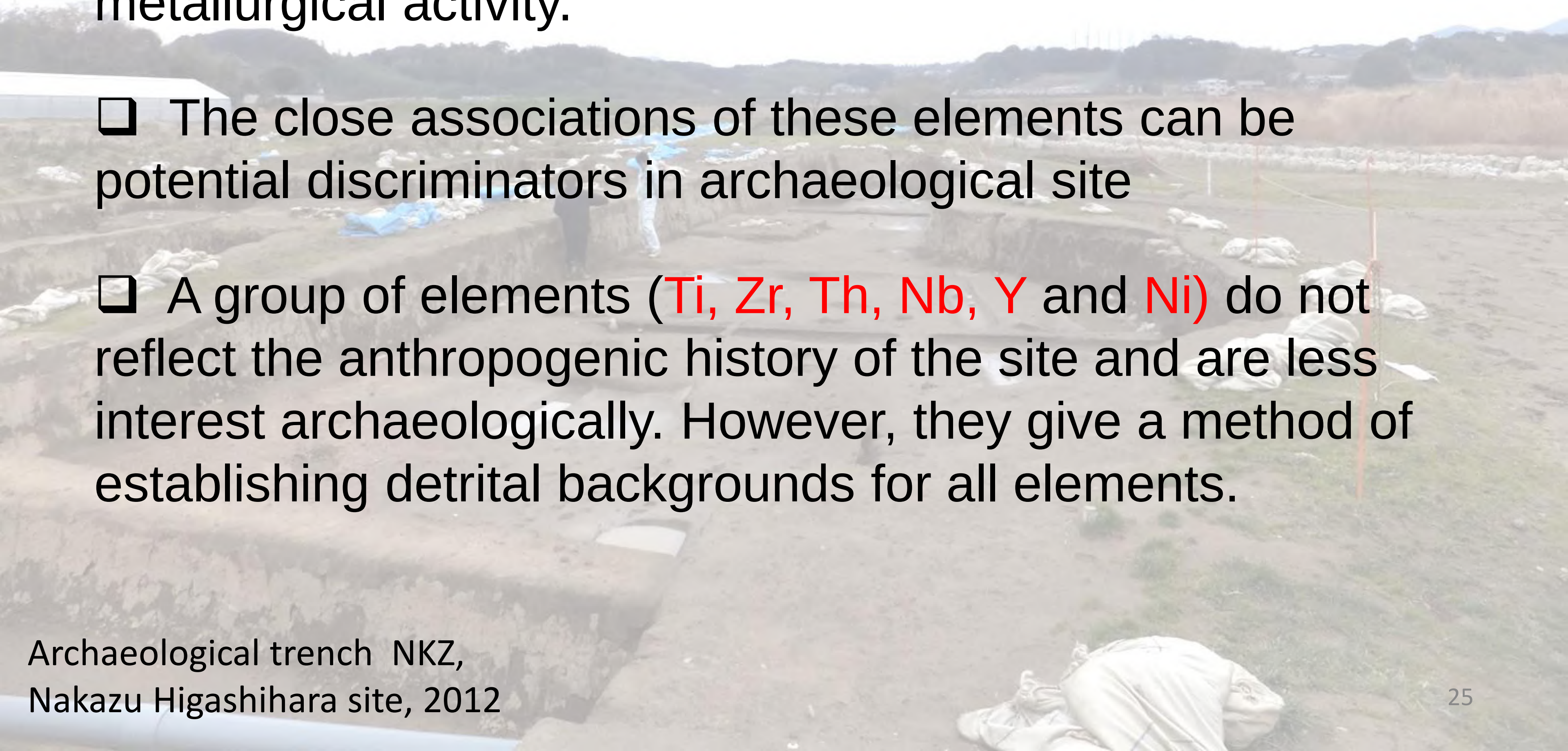
Boulder paved port site,
Nakazu Higashihara, 2011

Conclusions

- Association of As, Pb, Zn, Cu, V, Sc, Mn, Fe and P found in the smithy area are compatible with the effects of ancient metallurgical activity.

- The close associations of these elements can be potential discriminators in archaeological site

- A group of elements (Ti, Zr, Th, Nb, Y and Ni) do not reflect the anthropogenic history of the site and are less interest archaeologically. However, they give a method of establishing detrital backgrounds for all elements.



Archaeological trench NKZ,
Nakazu Higashihara site, 2012

Study 2

Introduction

The present and future water supply of Ulaanbaatar city depends totally on surface water and groundwater along the Tuul River.

Hence, sustainable development of the Tuul River basin and its ecological condition are critical for the population of Ulaanbaatar.

Scope and objectives

- To determine the geochemical composition of the Tuul River sediments in relation to their provenance

- To assess the impact of urban activity on the river sediments and to evaluate the level of heavy metal contamination.

Materials and methods

- River surface water and groundwater

  Physical properties (t°, pH, EC, DO and ORP)

  Chemical properties (COD, total iron Fe^-, NO_3^-, NH_4^+ and PO_4^{3-})

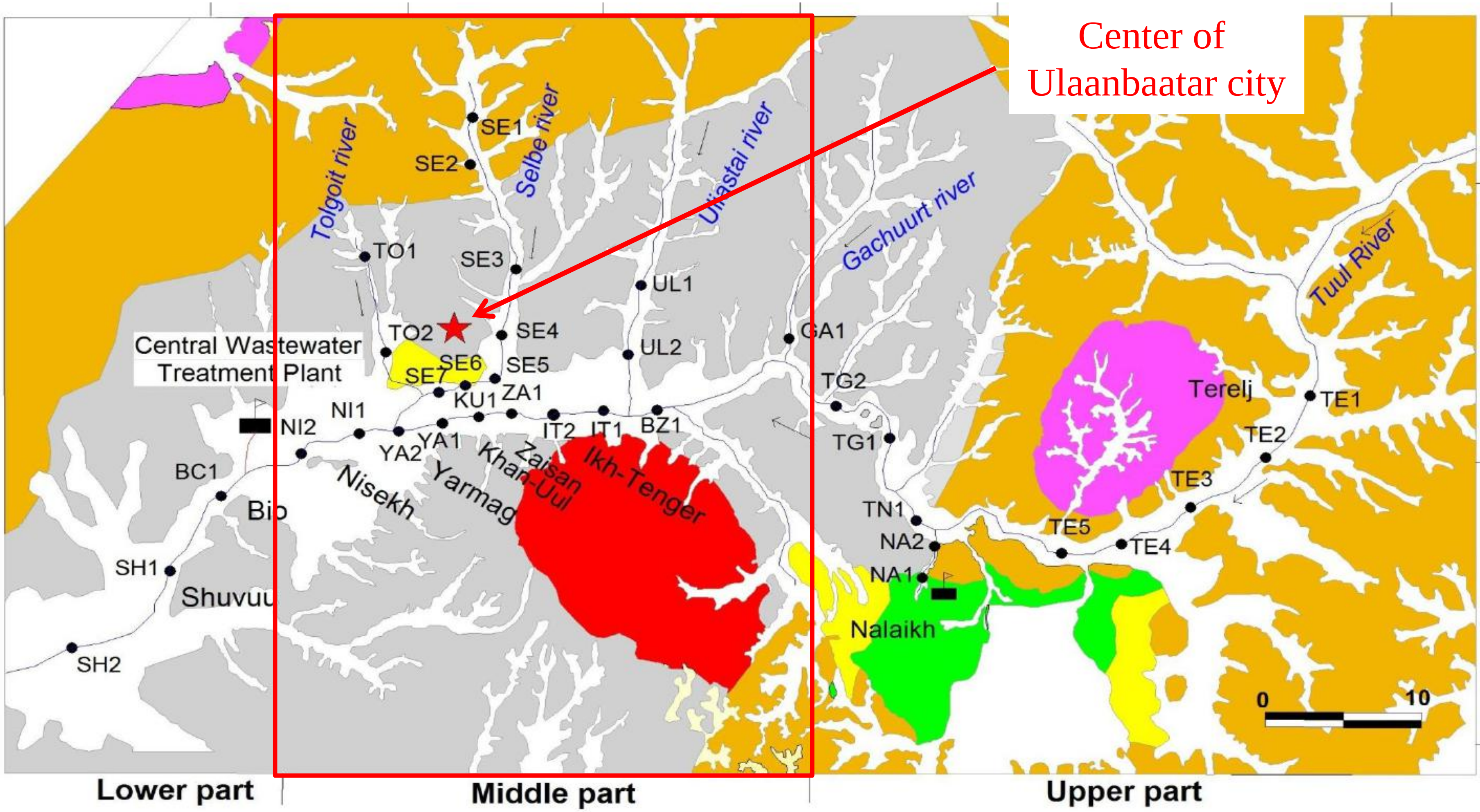
- River sediments

  Physical properties (ORP and pH)

  XRF analysis (major and trace elements)

- Data interpretation

Sampling points



Ulaanbaatar basin divided into three parts (upper, middle and lower) according to the extent of urbanization.

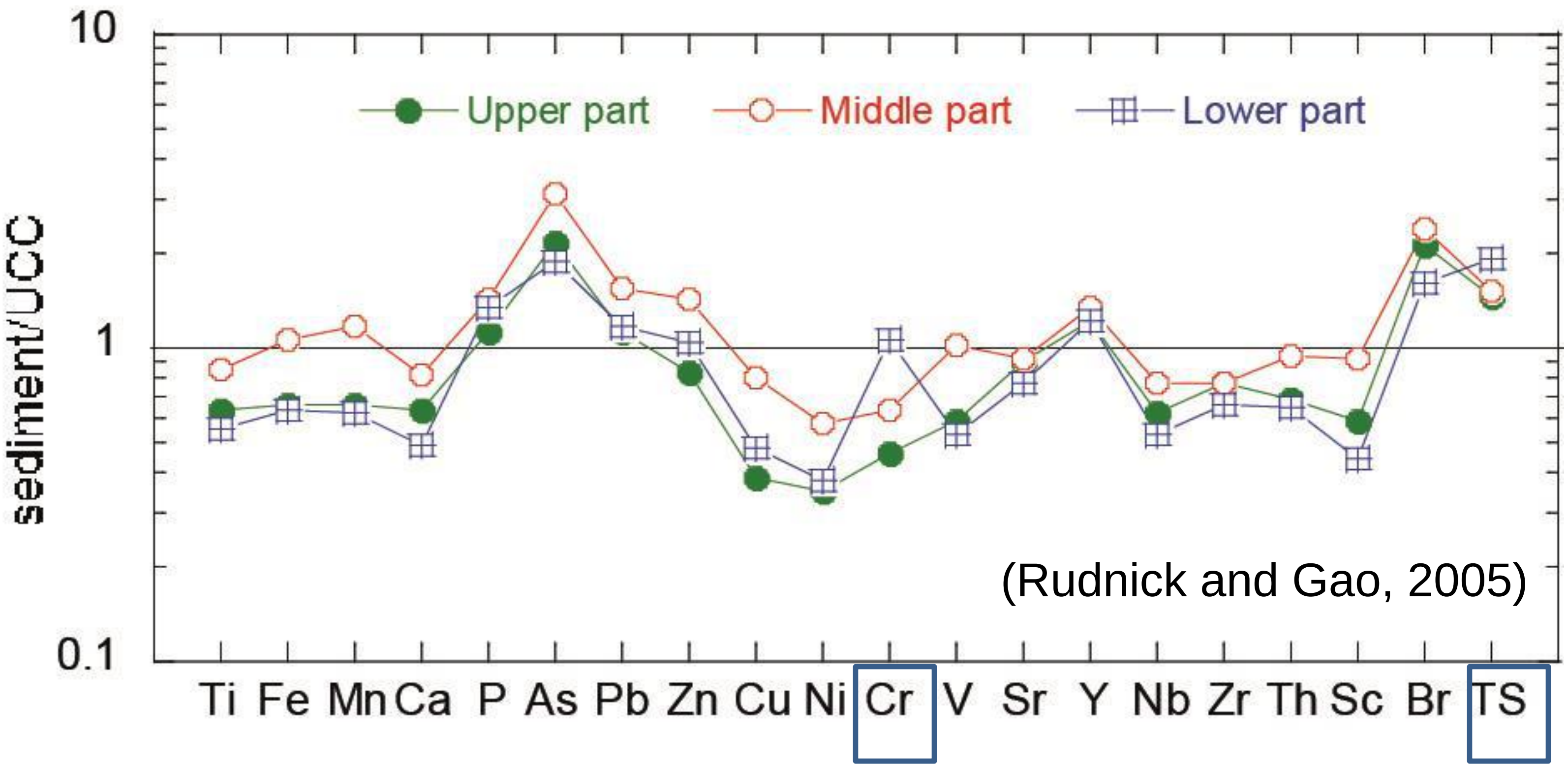
Results and Discussion

Element	Upper part		Middle part		Lower part	
	Mean	Range	Mean	Range	Mean	Range
TiO_2	0.40	0.22-0.53	0.54	0.36-0.67	0.35	0.12-0.54
Fe_2O_3	3.33	1.39-5.47	5.32	3.54-7.02	3.18	1.14-5.23
MnO	0.07	0.03-0.11	0.12	0.09-0.20	0.06	0.02-0.11
CaO	2.28	1.30-6.20	2.94	1.55-5.59	1.77	1.21-2.25
P_2O_5	0.17	0.08-0.35	0.21	0.13-0.32	0.20	0.08-0.33
As	10	7-20	15	8-23	9	6-14
Pb	19	18-24	26	13-46	20	18-23
Zn	56	21-142	97	37-171	69	22-123
Cu	11	4-33	23	6-41	13	4-24
Ni	16	10-28	27	12-35	18	9-27
Cr	42	24-55	59	40-74	98	26-183
V	57	15-103	100	52-141	51	2-99
Sr	289	211-440	294	242-399	251	205-281
Y	26	21-30	28	20-34	26	20-31
Nb	7	7-9	9	6-11	6	3-9
Zr	149	116-165	148	120-187	128	87-157
Th	7	4-13	10	7-12	7	3-12
Sc	8	3-20	13	4-19	6	1-11
Br	3	2-11	4	2-6	3	2-4
TS	909	404-2048	935	22-1553	1204	493-1786

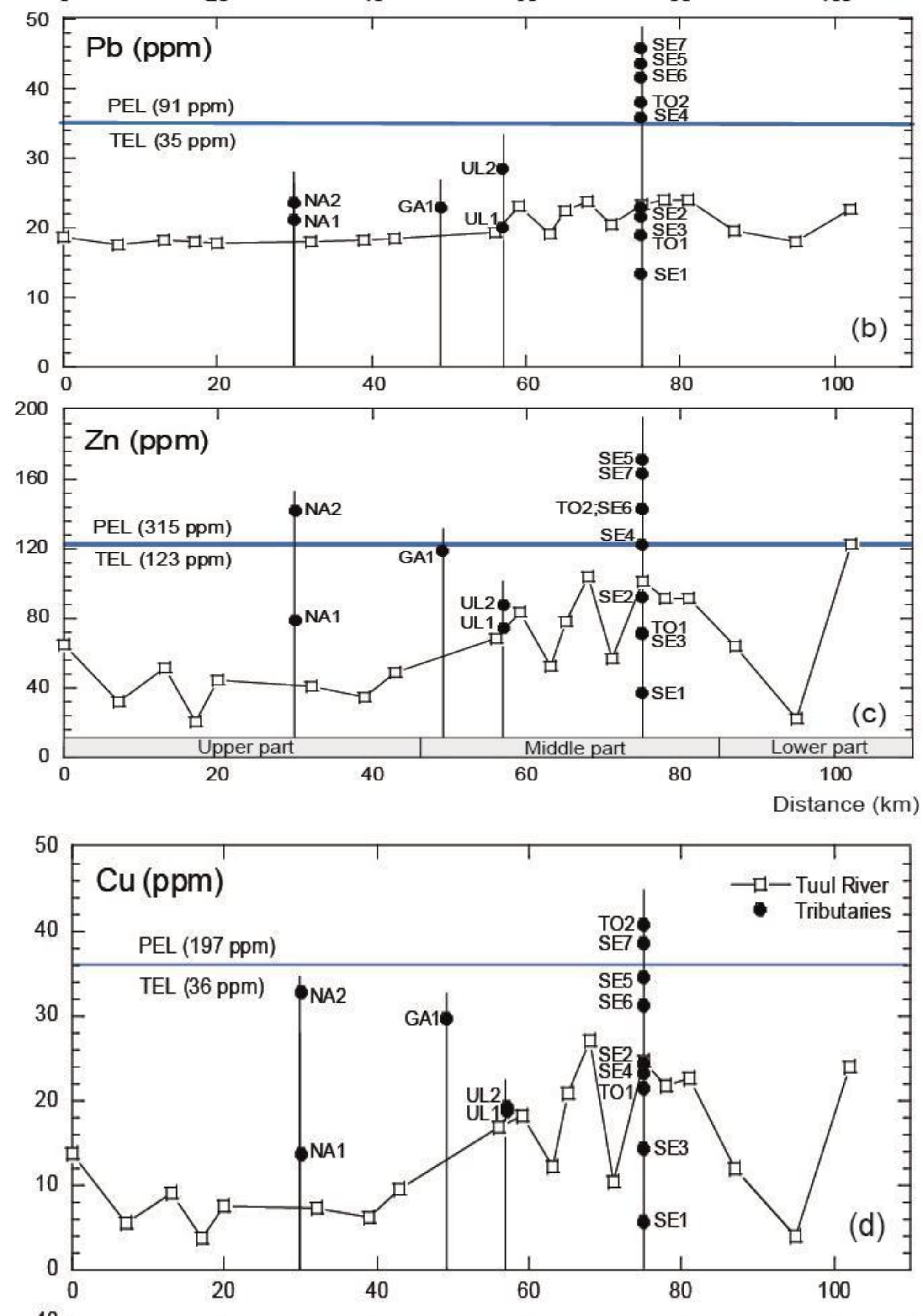
Geochemical composition of the sediments

- Heavy metals **As, Pb, Zn, Cu, Ni, V** are higher in the **Middle part** within the city
- **Lower part** enriched by **Cr** and **TS**
- Lithophile and HFSE elements **do not differ** between the three parts.

Evaluation of sediment source composition



Depletion of many elements relative to UCC suggests that the Tuul sediments were derived from a geochemically uniforms and felsic source.

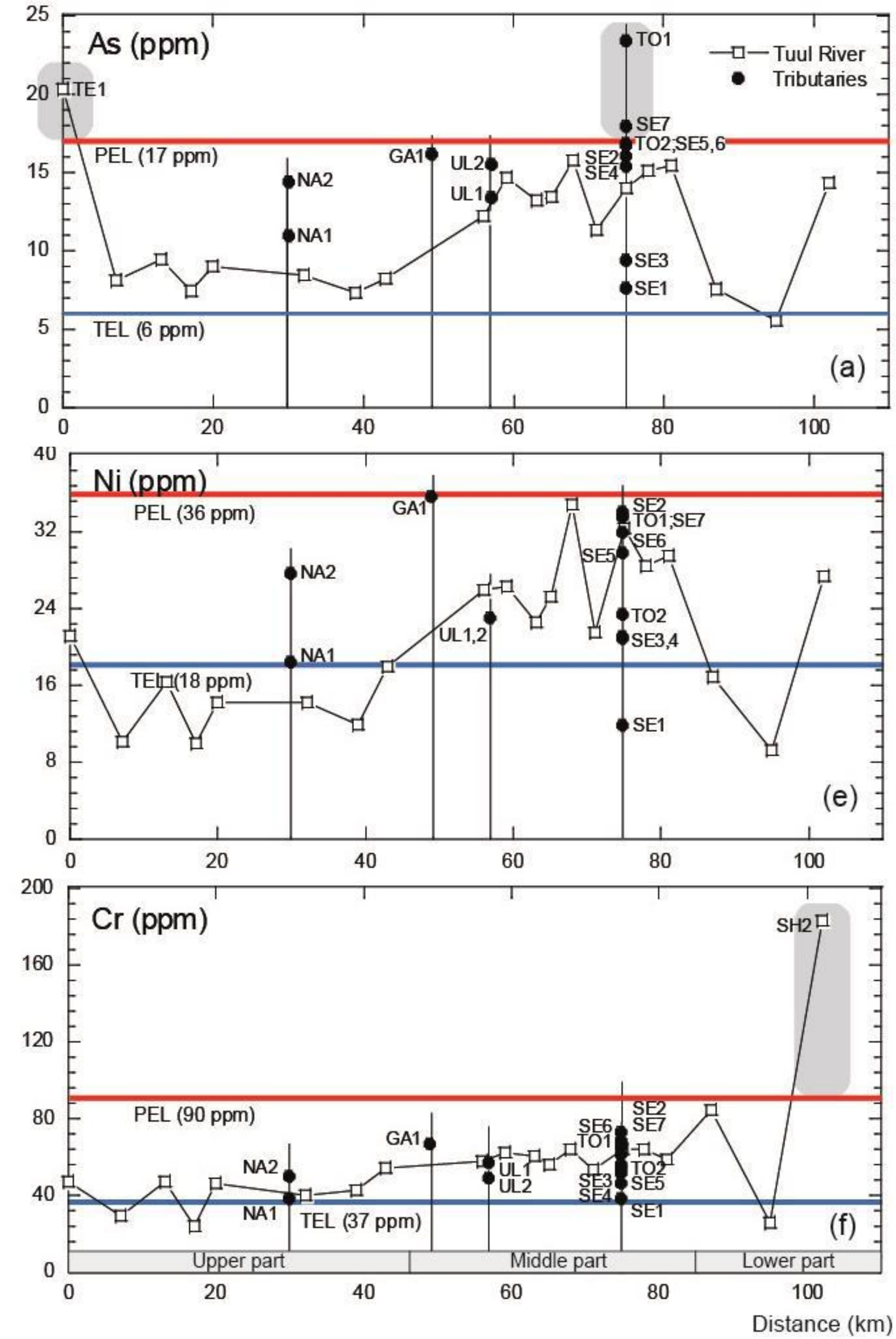


Assessment of sediment contamination

<u>Sediment quality guidelines (SQG) are useful indicators of metal contamination (MacDonald et al. 2000).</u>

- Tuul R. below the TEL (Threshold effect level)
- Levels increase in the Middle part within the city
- Tributaries exceed the TEL

Indicate: moderate contamination of Pb, Zn and Cu



➢Middle part borders on PEL (Probable Effect Level)
As, Ni and Cr

- Levels could be elevated in future

➢Upper and Middle part some samples exceed the PEL for As

- natural and anthropogenic influences

➢Lower part double the PEL for Cr

- potential impact on biota health
- tannery discharges of wastes

Conclusions

- Environmentally toxic metals such as As, Pb, Zn, Cu, Ni, Cr and V are higher in the middle part (within the city).

- The assessment using SQG shows As and Cr are present at levels that cause adverse aquatic biological effects.

- Concentrations of Pb, Zn, Cu and Ni are generally below their respective TEL. In the middle reaches values increase and border on the PEL, suggest significant anthropogenic contamination in the urban areas, increasing values above a naturally low regional background.

Thank you