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# Mechanical and Chemical Quality of Fine Aggregates of Riverbed and Floodplain of Keum River Basin in Korea

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## Abstract

The paper presents new grain size, aggregate test, geochemical (major elements) and mineralogical data on sands in the lowers of the Gongju Geum River basin in South Korea. The properties of sand-rich stream sediments from the floodplain and riverbeds are closely linked to the structure and composition of the bedrock. However, because of the Basin's simple bedrock assemblage, the particle size is more important than the bedrock type for sand properties evaluation. The sand samples from the floodplain of the Gongju Geum River Basin have coarser grain size, higher density, and higher quartz concentrations compared to those from the riverbed. The concentrations of $SiO_2$ are well correlated with other major elements in the sand from the riverbed, but not in the floodplain. This suggests that weathering was a dominating process in the floodplain, while fluvial sorting dominated in the riverbed. The quality of the sand aggregates from the floodplain and riverbed of the Gongu Geum River Basin is sufficient to fit the KE standards/categories for fine aggregates.

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## Keywords:

Fluvial aggregate, Riverbed, Foodplain, Sand composition, Mechanical property

## Introduction

Sand is the most abundant sedimentary material in riverbeds, dunes and coastal deposits. The human use of sand implies matching the demands of commercial supplies of sand aggregates. Although crushed aggregates are still widely used, a lot of environmental problems arise while using those technologies. So, we should take into account the environmental problems, which have become of higher importance during the last years. The use of sand would provide more environmental protection and more efficient use of natural resources, and therefore careful investigation and exploration of sand resources seem to be necessary. A promising alternative of crushed aggregates is fluvial sand deposits derived from upstream source rocks. Integrated surveys of fluvial deposits based on their aggregate characteristics would contribute to economic and sustainable environmental development. Fisher and Smith [1] concluded that main technical properties of aggregates depend on the type and distribution of parental rock within a river basin. In the Korean Peninsula, several localities of fine aggregates formed in various environments, including floodplains and riverbeds, have been studied before [2-4]. On a number of reasons, no adequate assessment of geological features, geochemical and mechanical

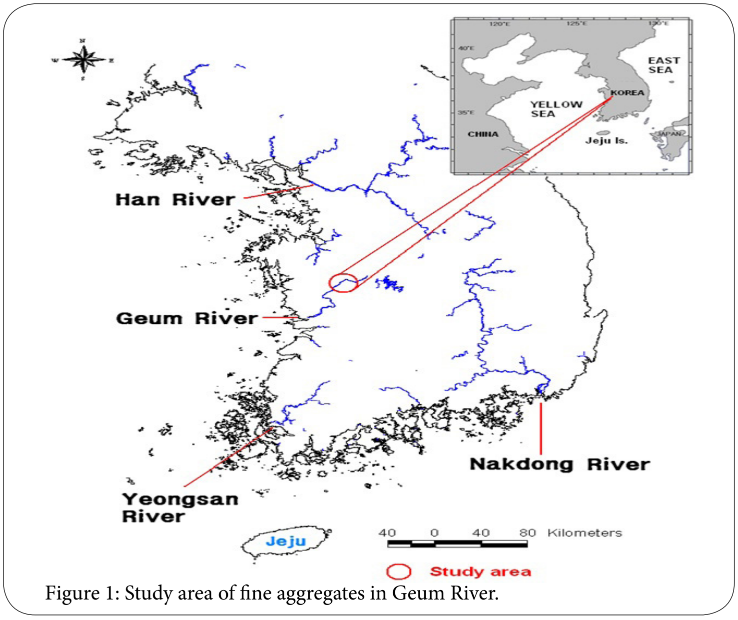

Figure 1: Study area of fine aggregates in Geum River.

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properties of fine-grained aggregates (sand) in Quaternary riverbeds and floodplains of the Geum River in Korea has been made so far.

Fluvial sands are widely distributed within the modern and paleo riverbeds of the Geum River, at its Yugu and Jeongan distributaries (Figure 1)[5]. A major part of the present riverbed sand sequence was formed at 3,000~6,000 yrBP, i.e. during the mid- to late Holocene. However, the radiocarbon AMS dating of organic muds from the flood plain yielded 9,430 yrBP, therefore, the sand deposits underlying the organic muds formed during the latest Pleistocene to the Early Holocene [5]. It was suggested that the transportation of sands of the Geum river and its distributaries from paleo riverbeds and paleo overbank flooding was maximal at the time of warm and wet climate accompanied by heavy precipitation, i.e., during the strong Summer Monsoon period [5].

## Sampling and Methods

The Geum is the third longest river in South Korea, which is 401 km long (Figure 1). The drainage area of the Geum River Basin is 9,859 km$^2$. The study area is located near Gongju city, in the mid-stream of the Geum River and encompasses the floodplain and riverbeds of the Geum River (Figure 1). The basement of the Geum mid-stream area is dominated by easily weathered Mesozoic granites, while the Geum upper-stream area consists of Precambrian gneisses, which are more resistant to surface erosion. The provenance of fluvial sediments, i.e. the source of fine aggregates, includes both Precambrian gneisses and Mesozoic granites. The ancient and modern riverbeds or flood plains have been historically cultivated and used as a source of fine-grained aggregates. The samples of floodplain and riverbed sands were taken along the river course using a rotary coring sampler and a shovel. Location, bedrock depth and thickness of sand and gravel beds are shown in Table 1 and Figure 2.

| Borehole | Location (latitude, longitude) | Depth of bedrock (m) | Thickness of Sand & gravel (m) | Thickness of Sand (m) | Ref. |
|---|---|---|---|---|---|
| KJL-01 | N 36°28′34″, E 127°07′43″ | 10.0 | 6.1 | 6.0 | floodplain |
| KJL-02 | N 36°34′35″, E 126°58′01″ | 6.0 | 4.0 | 3.0 | floodplain |
| KJL-03 | N 36°33′59″, E 126°57′53″ | 4.4 | 2.0 | 1.7 | floodplain |
| KJL-04 | N 36°31′51″, E 126°56′59″ | 4.5 | 3.2 | 3.0 | floodplain |
| KJL-05 | N 36°31′22″, E 126°57′15″ | 4.0 | 2.8 | 2.4 | floodplain |
| KJL-06 | N 36°30′39″, E 126°58′12″ | 3.0 | 1.0 | 0.8 | floodplain |
| KJL-07 | N 36°30′14″, E 126°59′41″ | 6.0 | 3.4 | 2.9 | floodplain |
| KJL-08 | N 36°18′12″, E 127°04′26″ | 8.0 | 2.8 | 2.7 | floodplain |
| KJL-09 | N 36°25′58″, E 127°09′02″ | 5.0 | 2.1 | 1.8 | floodplain |
| KJL-10 | N 36°20′43″, E 127°08′32″ | 5.0 | 2.1 | 1.5 | floodplain |
| KJL-11 | N 36°20′03″, E 127°08′34″ | 5.0 | 3.4 | 2.9 | floodplain |
| KJL-12 | N 36°19′29″, E 127°08′37″ | 5.0 | 2.0 | 1.7 | floodplain |
| KJL-13 | N 36°18′57″, E 127°08′33″ | 5.0 | 1.3 | 1.0 | floodplain |
| KJL-14 | N 36°18′28″, E 127°08′26″ | 4.0 | 2.3 | 1.4 | floodplain |
| KJL-15 | N 36°18′58″, E 127°07′59″ | 4.0 | 1.5 | 1.2 | floodplain |
| KJL-16 | N 36°32′06″, E 127°11′37″ | 4.0 | 1.3 | 1.0 | floodplain |
| KJL-17 | N 36°30′15″, E 127°11′41″ | 6.0 | 3.6 | 3.3 | floodplain |
| KJL-18 | N 36°30′02″, E 127°07′57″ | 7.0 | 3.3 | 3.0 | floodplain |
| KJL-19 | N 36°30′55″, E 127°07′36″ | 7.0 | 3.8 | 2.9 | floodplain |
| KJL-20 | N 36°31′13″, E 127°07′19″ | 7.0 | 3.3 | 2.9 | floodplain |
| KJL-21 | N 36°32′18″, E 127°07′16″ | 7.0 | 4.2 | 3.8 | floodplain |
| KJL-22 | N 36°33′19″, E 127°07′07″ | 6.0 | 4.8 | 4.0 | floodplain |
| KJL-23 | N 36°36′01″, E 127°07′09″ | 5.0 | 2.6 | 2.0 | floodplain |
| KJL-24 | N 36°28′29″, E 127°06′56″ | 14.0 | 4.3 | 4.2 | floodplain |
| KJL-25 | N 36°29′28″, E 127°05′27″ | 5.0 | 2.0 | 1.5 | floodplain |
| KJL-26 | N 36°27′37″, E 127°05′09″ | 12.0 | 3.7 | 3.6 | floodplain |
| KJL-27 | N 36°28′19″, E 127°04′48″ | 8.0 | 1.1 | 1.0 | floodplain |
| KJL-28 | N 36°28′06″, E 127°04′15″ | 10.0 | 4.5 | 3.5 | floodplain |
| KJL-29 | N 36°27′50″, E 127°04′03″ | 8.0 | 2.7 | 2.5 | floodplain |
| KJL-30 | N 36°27′37″, E 127°03′46″ | 8.5 | 4.6 | 3.9 | floodplain |
| KJL-31 | N 36°28′59″, E 127°02′01″ | 7.0 | 6.4 | 5.1 | floodplain |
| KJL-32 | N 36°25′46″, E 127°01′15″ | 4.0 | 2.3 | 1.8 | floodplain |

Continue...

| | | | | | |
|---|---|---|---|---|---|
| KJL-33 | N 36°24′35″, E 127°02′30″ | 16.0 | 5.7 | 4.6 | floodplain |
| KJL-34 | N 36°22′56″, E 127°04′31″ | 4.0 | 0.7 | 0.7 | floodplain |
| KJL-35 | N 36°30′16″, E 127°08′35″ | 5.0 | 2.2 | 1.8 | floodplain |
| KJR-01 | N 36°28′13″, E 127°07′12″ | 11.5 | 6.5 | 6.4 | riverbeds |
| KJR-02 | N 36°27′57″, E 127°06′11″ | 11.5 | 9.3 | 9.1 | riverbeds |
| KJR-03 | N 36°26′55″, E 127°04′58″ | 6.5 | 6.0 | 5.7 | riverbeds |
| KJR-04 | N 36°26′11″, E 127°03′44″ | 8.1 | 2.1 | 2.1 | riverbeds |
| KJR-05 | N 36°23′21″, E 127°01′16″ | 12.7 | 2.1 | 1.8 | riverbeds |
| KJR-06 | N 36°21′05″, E 127°59′18″ | 5.7 | 3.5 | 3.5 | riverbeds |
| KJR-07 | N 36°27′45″, E 127°04′42″ | 10.6 | 9.9 | 9.6 | riverbeds |
| KR-01 | N 36°26′02″, E 127°12′58″ | - | - | - | river sand |
| KR-02 | N 36°27′31″, E 127°14′29″ | - | - | - | river sand |
| KR-03 | N 36°26′32″, E 127°10′58″ | - | - | - | river sand |
| KR-04 | N 36°26′57″, E 127°09′52″ | - | - | - | river sand |
| KR-05 | N 36°27′51″, E 127°07′49″ | - | - | - | river sand |
| KR-06 | N 36°27′59″, E 127°06′14″ | - | - | - | river sand |
| KR-07 | N 36°26′20″, E 127°03′52″ | - | - | - | river sand |
| KR-08 | N 36°22′43″, E 127°00′23″ | - | - | - | river sand |
| KR-09 | N 36°23′51″, E 127°01′48″ | - | - | - | river sand |
| KR-10 | N 36°20′35″, E 126°59′19″ | - | - | - | river sand |
| KR-11 | N 36°22′16″, E 126°59′36″ | - | - | - | river sand |
| KR-12 | N 36°26′52″, E 127°04′58″ | - | - | - | river sand |
| KR-13 | N 36°24′55″, E 127°02′54″ | - | - | - | river sand |
| YGS-01 | N 36°27′36″, E 127°05′19″ | - | - | - | river sand |
| YGS-02 | N 36°27′50″, E 127°03′41″ | - | - | - | river sand |
| JAS-01 | N 36°34′14″, E 127°07′45″ | - | - | - | river sand |
| JAS-02 | N 36°35′41″, E 127°07′07″ | - | - | - | river sand |
| JAS-03 | N 36°28′40″, E 127°07′55″ | - | - | - | river sand |
| JAS-04 | N 36°30′44″, E 127°07′28″ | - | - | - | river sand |

Table 1: Descriptions of fine aggregates sampled from the floodplain and riverbeds of the Geum River.

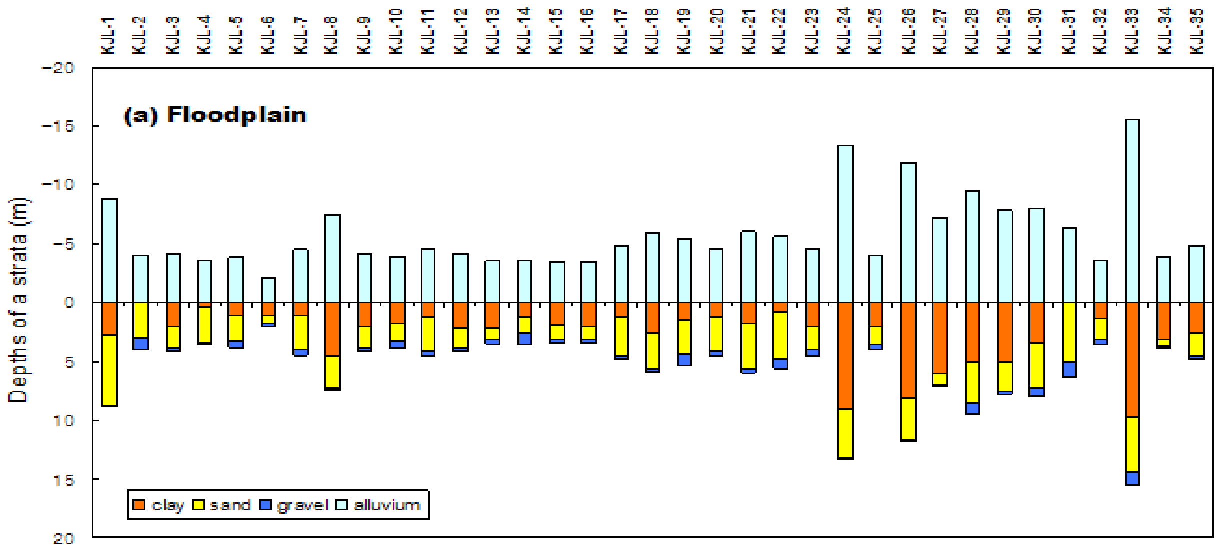


Figure 2: Depths of clay, sand, gravel and total alluvium from sediment profiles of Geum River.

The samples were analyzed for grain size distribution, major element components, mineral composition and fine aggregate using Korea Standard methods. Grain size measurement was carried out using wet sieving (more than 0.5 mm) and Master Sizer 2000 (less than 0.5 mm), which corresponds to the Korean KS F 2502 [6]. A Series standard and meets nearly ISO 6274 standard. Grain size distribution was calculated by weight percentage. X-ray diffractometry (XRD) was carried out with a Philips PW 1730/1735 machine, using a 200 mesh powder for determining mineral chemistry. X-ray fluorescence spectrometric analysis (XRF) was carried out using a Shimadzu MXF-2100 using a 200 mesh powder sample. The weight percentages of $SiO_2$, $Al_2O_3$, $Fe_2O_3$, CaO, $K_2O$, MgO, $Na_2O$, $TiO_2$, MnO and $P_2O_5$ were calculated.

The assessment of engineering properties using Korea Standard (KS) categories requires consideration of particle size distribution (including materials finer than 0.075mm), density, absorption, soundness and chloride content. The KS categories of testing methods and quality control for aggregates were referred to the standards of the American Society for Testing and Materials (ASTM): ASTM E 112

| Test \ Country | South Korea (Korea Standard) | | USA (ASTM) | |
|---|---|---|---|---|
| | Coarse aggregates | Fine aggregates | Coarse aggregates | Fine aggregates |
| Density (g/cm3) | 2.5 | 2.5 | 2.6 | |
| Absorption (%) | 3.0 | 5.0 | | |
| Bulk density (kg/m3) | 1,250 | - | 1,250 | - |
| Clay lumps and friable particles (%) | 5.0 | 3.0 | 2.0 | 1.0 |
| Materials finer than 75µm (%) | 1.0 | 3.0 | 1.0 | 3.0 |
| Soundness (%) | 12 | 10 | 18 | 15 |
| Los Angels abrasion (%) | 40 | - | 50 | - |
| Chloride content (%) | 0.3kg/m3 | 0.04-0.1N | | 0.06-0.2N |
| Organic impurities (%) | 1.5 | 5.0 | 1.5 | 5.0 |

All limits are less than the controls except density and bulk density that are more than the controls.

Table 2: The quality control limits of fine and coarse aggregate in comparison with KS(Korea) and ASTM(USA).

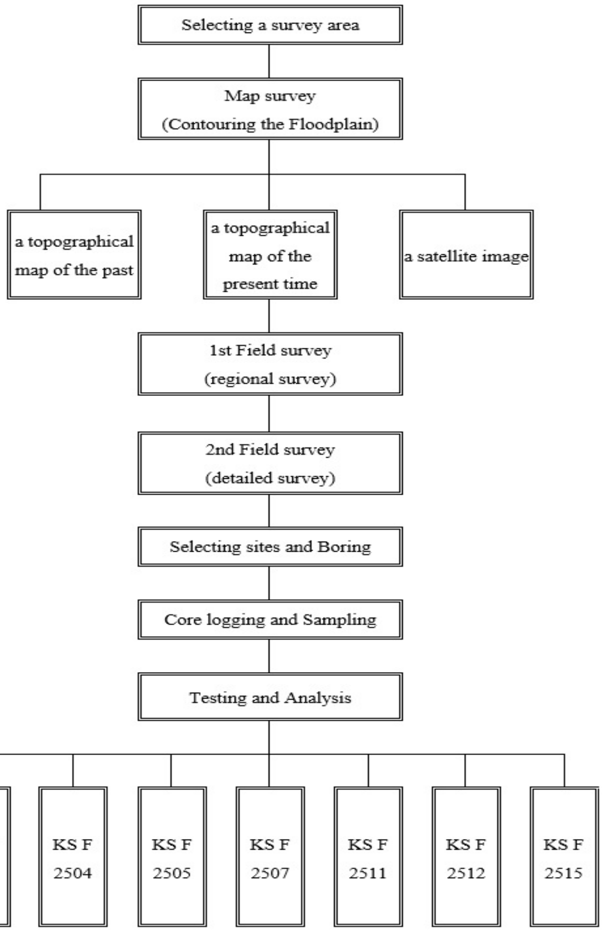


Figure 3: Flow chart for test procedure of borehole samples.

[7], ASTM C 142 [8], ASTM C 88a [9], ASTM C 1524a [10], ASTM C 131 [11], ASTM C 33 [12], ASTM C 29/C 29M [13], ASTM C 40 [14], ASTM C 117 [15], ASTM C 128a [16], ASTM C 136 [17]. Table 2 presents the test categories and quality control limits and figure 3 shows the flowchart for each test category of samples. The references for each KS test are provided in the reference list: KS F 2502 [6], KS F 2504 [18], KS F 2505 [19], KS F 2507 [20], KS F 2511 [21], KS F 2512 [22], KS F 2515 [23].

## Results

### Grain size

The grain size distribution of send-rich sediments was calculated by weight percent and the Cumulative Percent Passing graphs are presented (Figure 4). The fineness modulus of the material from the floodplain and riverbeds ranges from 2.40 to 4.07 and from 1.14 to 3.37 and the values of $D_{50}$ range from 0.53 mm to 2.12 mm and 0.23 mm to 1.23 mm, respectively (Figure 4). It is notable that the particle size of the sand-rich sediment in the floodplain is coarser than that of the sand-rich sediment in the riverbeds.

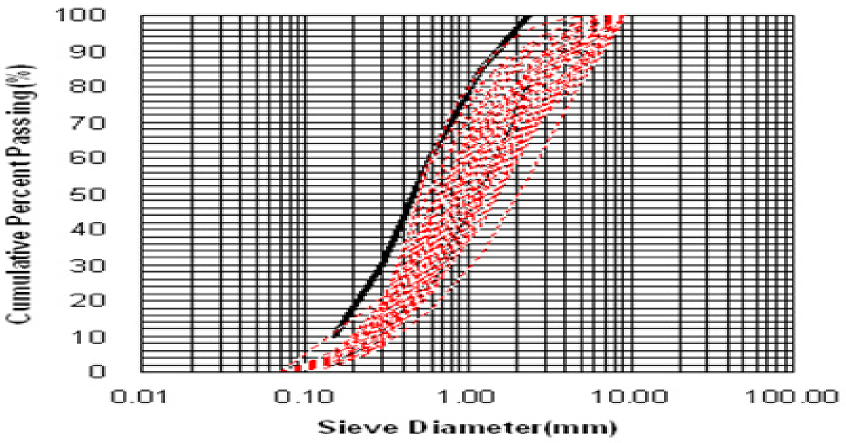
### Aggregate tests by Korea Standard categories

The portion of material finer 0.075 mm in the sand from the floodplain and riverbeds ranges from 0.35 to 3.70% and from 0.02 to 12.63%, respectively, and some of these exceed the qualification range for fine aggregates. The test showed that <0.075mm sand material is more abundant in the riverbeds than in the floodplain. The density of sand from the floodplain and riverbeds ranges from 2.49 to 2.62 and from 2.38 to 2.61, respectively, i.e., the average density of sand from the floodplain is higher than that of sand from the riverbeds. Several density values are beyond the KS quality limit (Table 2). The absorption of sand from the floodplain and riverbeds ranges from 0.92 to 2.37% and from 1.12 to 3.08%, respectively, i.e., the absorption of the sand from the floodplain is better than that of sand from the riverbeds. The soundness of sand from the floodplain and riverbeds ranges from 0.29 to 3.00% and from 0.34 to 8.24%, respectively, i.e., the soundness of the sand from the floodplain is better than that of sand from the riverbeds. All the absorption and soundness values are within the KS quality limit (Table 2). The content of chlorides in the sand from the floodplain and riverbeds ranges from 0.00 to 14.60 ppm and from 0.00 to 51.10 ppm and is within the KS quality limit (Table 2).

### Major elements

Figure 5 shows the concentrations of major element in the sand from the floodplain and riverbeds of the Geum River, which appear to be similar. The floodplain sand is characterized by higher $SiO_2$ but lower $Al_2O_3$, $TiO_2$, $Fe_2O_3$, $Na_2O$, $K_2O$ and MgO compared to the

(a) Fine aggregates in Floodplain



(b) Fine aggregates in Riverbed

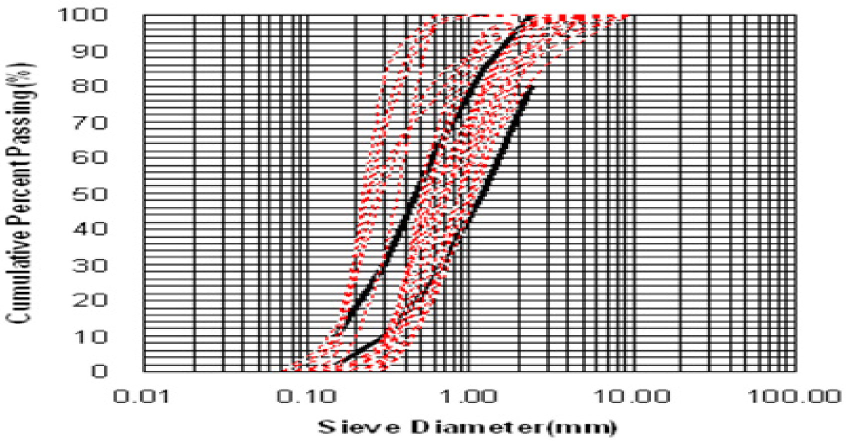


Figure 4: Grain size distribution curves of borehole samples.

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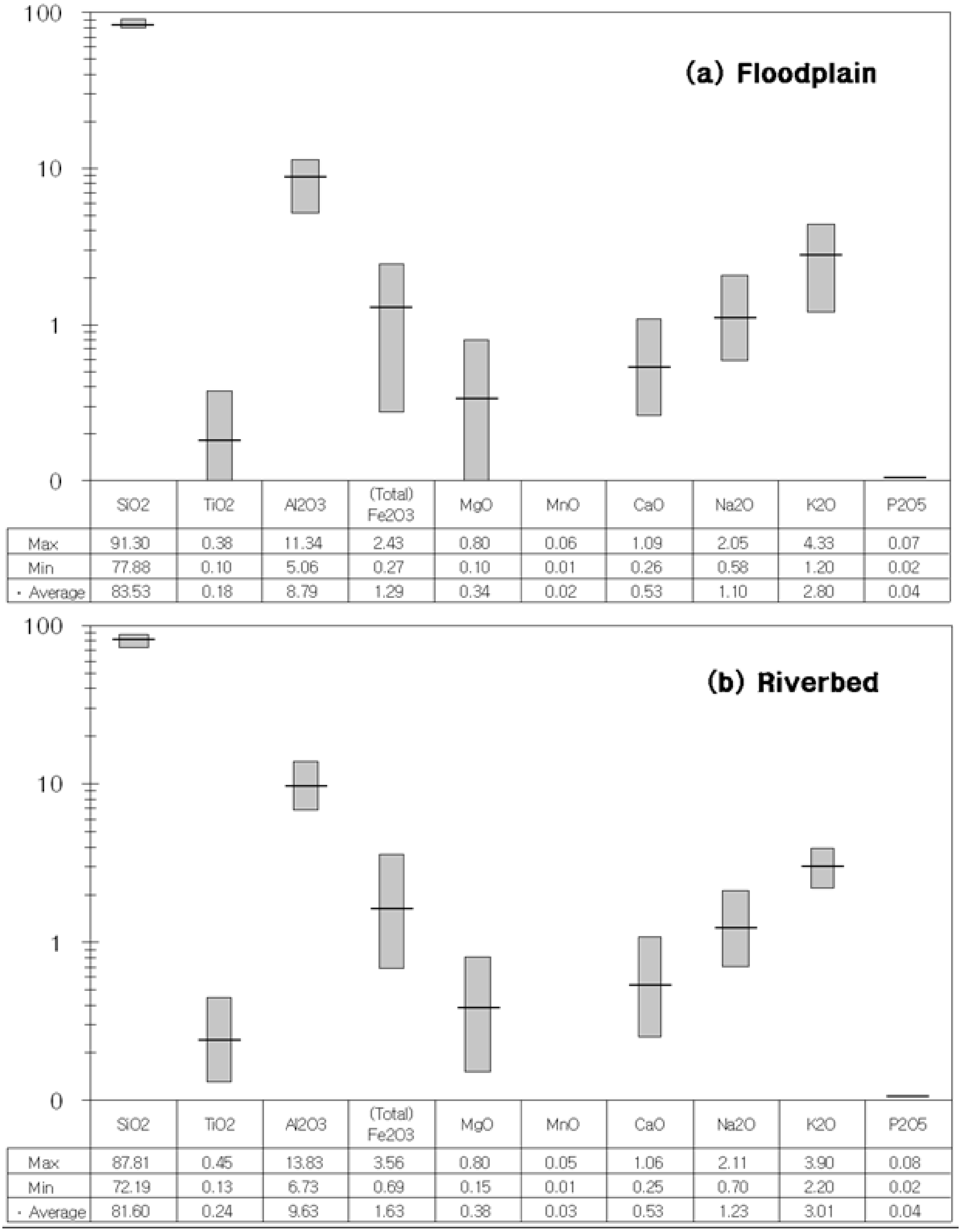
riverbed sand (Figure 5). In the SAM diagram (Figure 6) most samples agree fit the D & E-type trend corresponding to the basement granites. The concentrations of $SiO_2$ both in the floodplain sands and in the riverbed sands are negatively correlated with other major oxides (Figure 7). It shows that the sand samples from the floodplain and riverbeds of the Geum River Basin are chemically and mineralogically similar, which suggests relatively stable sedimentation environment (Figure 6 & Figure 7).



(a) Floodplain

| | SiO2 | TiO2 | Al2O3 | (Total) Fe2O3 | MgO | MnO | CaO | Na2O | K2O | P2O5 |
|---|---|---|---|---|---|---|---|---|---|---|
| Max | 91.30 | 0.38 | 11.34 | 2.43 | 0.80 | 0.06 | 1.09 | 2.05 | 4.33 | 0.07 |
| Min | 77.88 | 0.10 | 5.06 | 0.27 | 0.10 | 0.01 | 0.26 | 0.58 | 1.20 | 0.02 |
| · Average | 83.53 | 0.18 | 8.79 | 1.29 | 0.34 | 0.02 | 0.53 | 1.10 | 2.80 | 0.04 |

(b) Riverbed

| | SiO2 | TiO2 | Al2O3 | (Total) Fe2O3 | MgO | MnO | CaO | Na2O | K2O | P2O5 |
|---|---|---|---|---|---|---|---|---|---|---|
| Max | 87.81 | 0.45 | 13.83 | 3.56 | 0.80 | 0.05 | 1.06 | 2.11 | 3.90 | 0.08 |
| Min | 72.19 | 0.13 | 6.73 | 0.69 | 0.15 | 0.01 | 0.25 | 0.70 | 2.20 | 0.02 |
| · Average | 81.60 | 0.24 | 9.63 | 1.63 | 0.38 | 0.03 | 0.53 | 1.23 | 3.01 | 0.04 |

Figure 5: Distribution of major elements of floodplain and riverbed deposits.

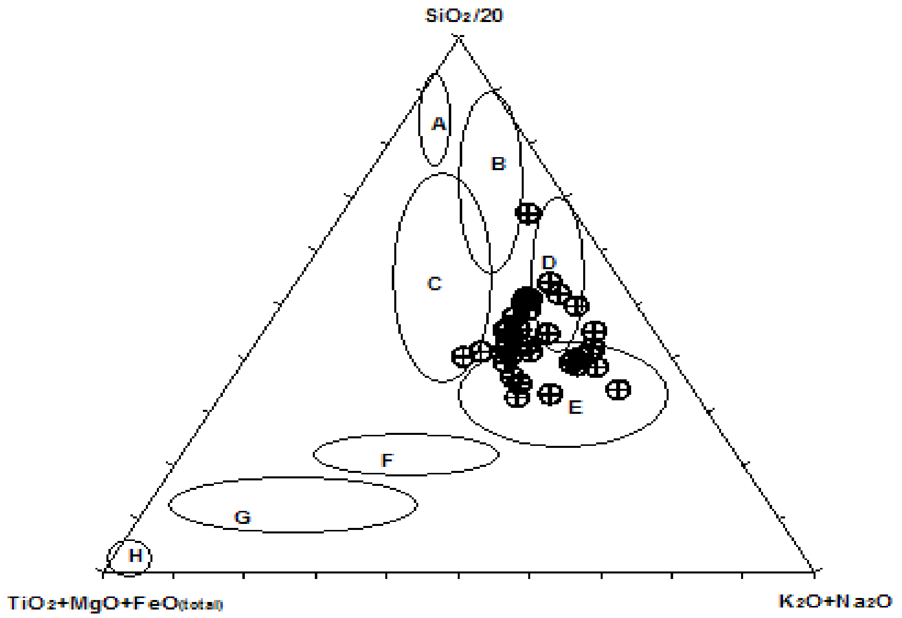
### Mineral components

The XRD patterns indicate the presence of quartz, plagioclase, K-feldspar, muscovite, biotite, chlorite and hornblende in the sand samples. The floodplain and riverbed sands are characterized by similar mineral assemblages, except Hornblende component (Figure 8).

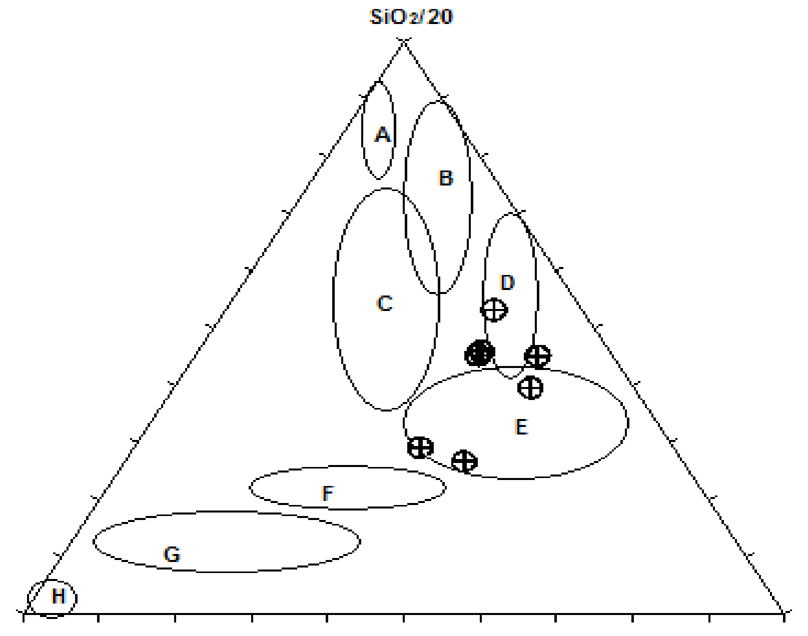
## Discussions

### Mechanical and engineering considerations

We performed mechanical and engineering tests determining standard grain size distribution in order to calculate precise sand

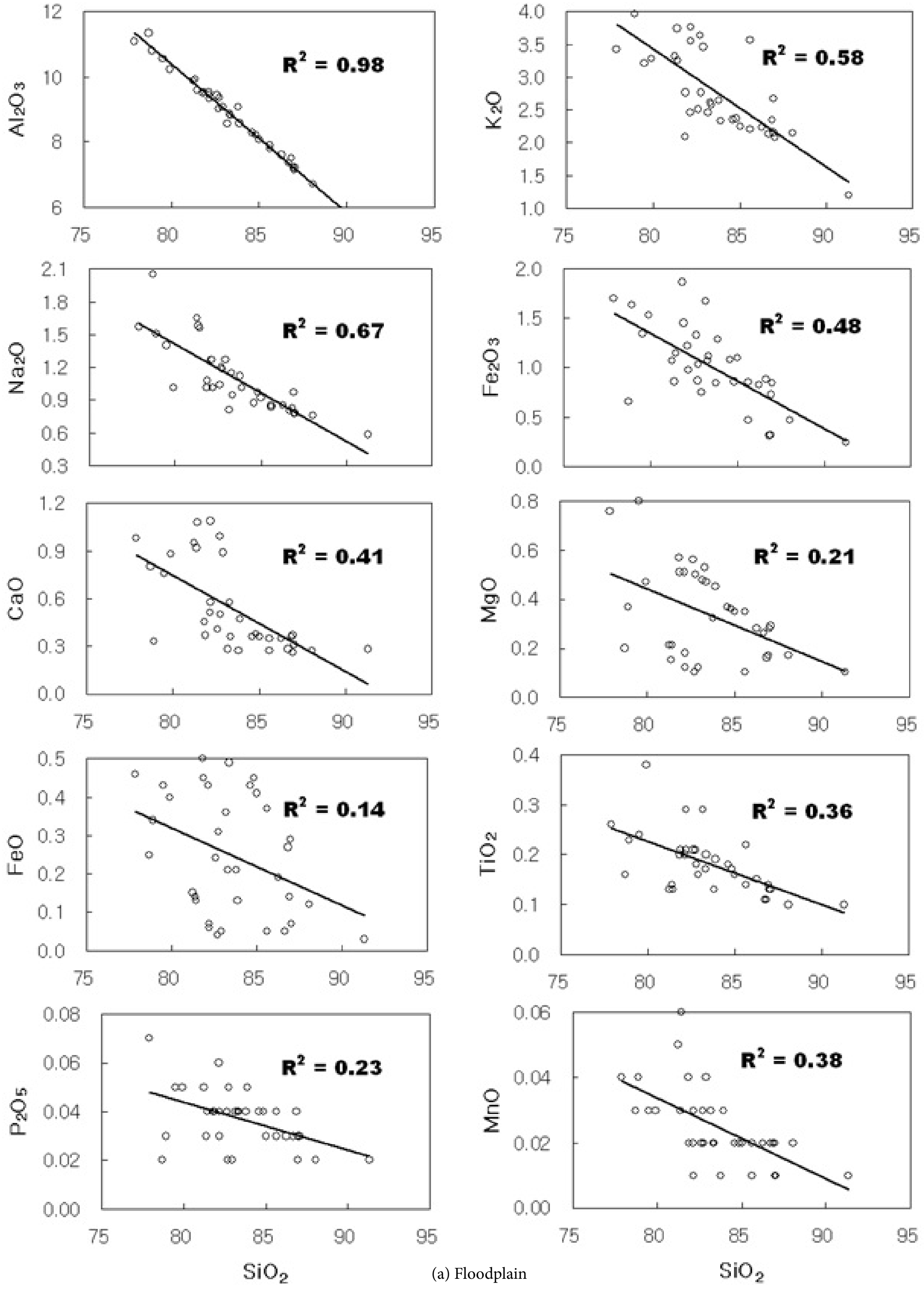


(a) Floodplain



(b) Riverbed

Figure 6: Plot of weight percentages of $SiO_2/20$, $Na_2O+K_2O$ and $TiO_2+MgO+FeO$(total) from the sand-rich sediments in this study area. A: Tertiary quartz sands (Amazonian provenance). B: Pleistocene Meuse + Rhine sands, North Limburg, the Netherlands. C: Pleistocene Meuse sands, South Limburg, the Netherlands. D: Plio-Pleistocene quartzofeldspathic Allier sands, France. E: Pleistocene-Holocene basement-rich, basalt-poor Allier sands, France. F: Pleistocene alkali basalt-rich, basement-poor sands, Allier River, France. G: Holocene andesitic sands, Atlantic Zone Rivers, Costa Rica. H: Placers, Costa Rica Atlantic beach and Caqueta River, Colombian Amazones (almost purely ferromagnesian sands).



(a) Floodplain

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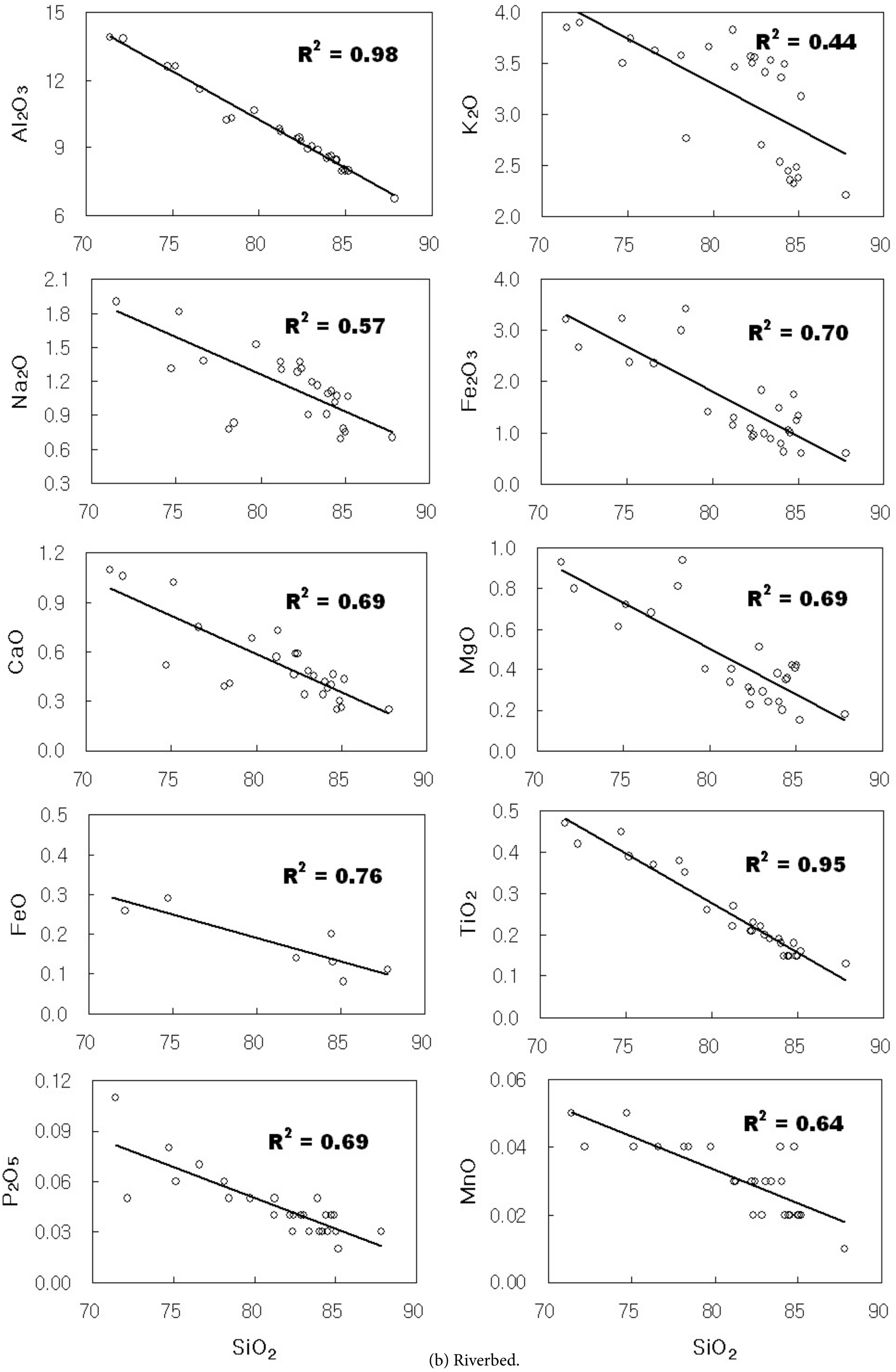
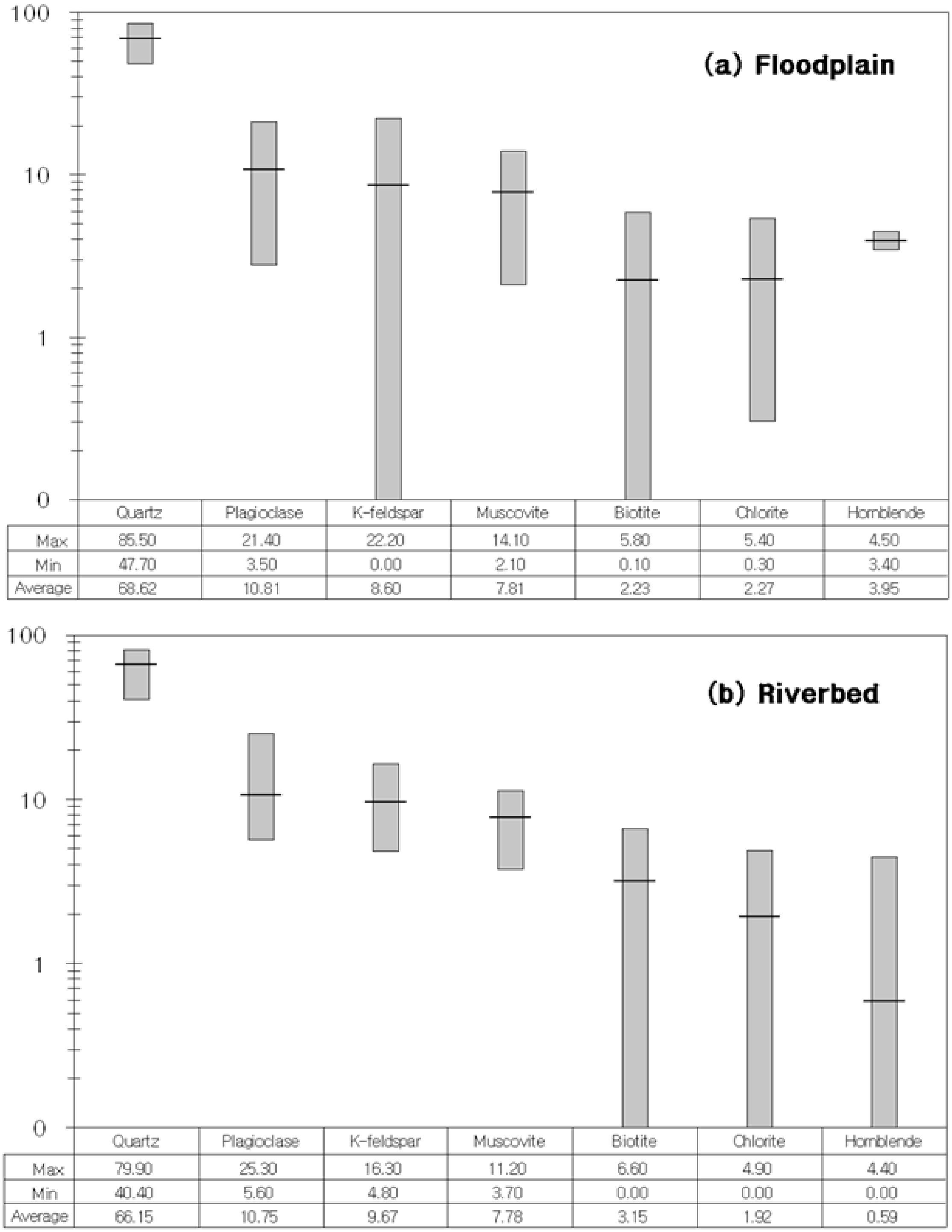


(b) Riverbed.

Figure 7: Diagram of major oxides versus Silica. (a) Floodplain, (b) Riverbed.



|  | Quartz | Plagioclase | K-feldspar | Muscovite | Biotite | Chlorite | Hornblende |
|---|---|---|---|---|---|---|---|
| Max | 85.50 | 21.40 | 22.20 | 14.10 | 5.80 | 5.40 | 4.50 |
| Min | 47.70 | 3.50 | 0.00 | 2.10 | 0.10 | 0.30 | 3.40 |
| Average | 68.62 | 10.81 | 8.60 | 7.81 | 2.23 | 2.27 | 3.95 |

|  | Quartz | Plagioclase | K-feldspar | Muscovite | Biotite | Chlorite | Hornblende |
|---|---|---|---|---|---|---|---|
| Max | 79.90 | 25.30 | 16.30 | 11.20 | 6.60 | 4.90 | 4.40 |
| Min | 40.40 | 5.60 | 4.80 | 3.70 | 0.00 | 0.00 | 0.00 |
| Average | 66.15 | 10.75 | 9.67 | 7.78 | 3.15 | 1.92 | 0.59 |

Figure 8: Mineral components of sand-rich sediments in the floodplain and riverbed.

ratios [1]. The characteristics of grain size vary in each sampled area and the standard grain size distribution is also different as the requirements for various uses [24]. The fineness modulus is the particle size ranging from 2.3 to 3.1. The fineness modulus of the unsorted borehole samples allowed us to evaluate the abundance and quality of the aggregate. The fine aggregate with a modulus of 2.3-3.1 was possibly formed by mixing with fine sand (Figure 9). Fineness modulus of the borehole samples differs for a fine aggregate mix in concrete mortar for construction. The sand-rich borehole samples do not have "blending sand". Usually, the higher the density is, the finer the grain size is [25], but our experiments did not confirm this. The disagreement comes from coarser grain size, higher density, higher ratios of $SiO_2$ and higher contents of quartz in the Geum River floodplain sand.

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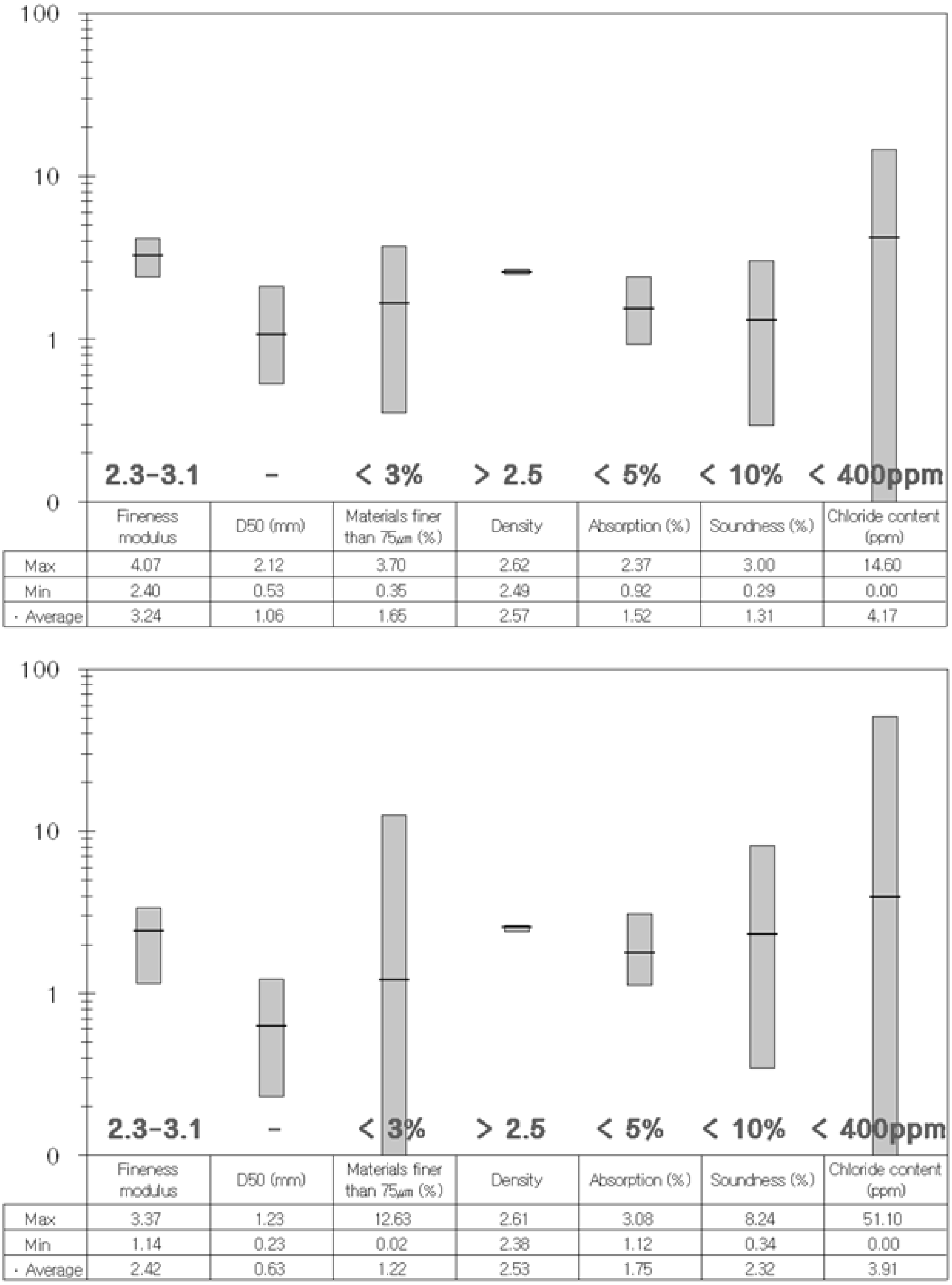

| | Fineness modulus | D50 (mm) | Materials finer than 75㎛ (%) | Density | Absorption (%) | Soundness (%) | Chloride content (ppm) |
|---|---|---|---|---|---|---|---|
| Max | 4.07 | 2.12 | 3.70 | 2.62 | 2.37 | 3.00 | 14.60 |
| Min | 2.40 | 0.53 | 0.35 | 2.49 | 0.92 | 0.29 | 0.00 |
| · Average | 3.24 | 1.06 | 1.65 | 2.57 | 1.52 | 1.31 | 4.17 |

| | Fineness modulus | D50 (mm) | Materials finer than 75㎛ (%) | Density | Absorption (%) | Soundness (%) | Chloride content (ppm) |
|---|---|---|---|---|---|---|---|
| Max | 3.37 | 1.23 | 12.63 | 2.61 | 3.08 | 8.24 | 51.10 |
| Min | 1.14 | 0.23 | 0.02 | 2.38 | 1.12 | 0.34 | 0.00 |
| · Average | 2.42 | 0.63 | 1.22 | 2.53 | 1.75 | 2.32 | 3.91 |

Figure 9: Mechanical properties of sand-rich sediments in each borehole samples as fine aggregates.

Coarse aggregate of the Geum River system is less reactive than that of other alluvial sites and no chloride contamination by human and animal wastewater is detected, therefore it is clear that sands of the Geum River had not been affected by salt water.

### Elemental, mineral and geological uniformity

The major element compositions between the floodplain and riverbed sands are similar. The major element compositions of the floodplain and riverbed sands between are similar. This conclusion corresponds to the idea that the stream sediments derived from K- and Si-rich igneous rocks have > 70% $SiO_2$, which is generally higher than in their parental rock [26]. In view of the results from a SAM diagram, the sediments from the Geum River Basin are mostly identical and the sedimentary environments are relatively simple.

$SiO_2$ concentrations of sands both from the floodplain and from riverbed are negatively correlated with other major oxide elements, although correlation coefficients are stronger in riverbed sands than in the floodplain sands. Quartz is generally resistant to weathering, so it is enriched in comparison with other major oxides or mineral components. Quartz has been utilized in the component variation plots of igneous series and sedimentary rock because it contains low concentrations of trace elements and high component variation in comparison with oxides [27]. The more $SiO_2$ concentrations increase, the more other major element concentrations decrease, which results from weathering process by fluvial sorting. $SiO_2$ and $Al_2O_3$ act as major components, because the concentrations of major elements from each borehole sample are identical as a result of the same parent rocks in the watershed of Geum River. Granite, granitic gneiss and quartz porphyry all have Si-rich mineral compositions, and Si concentrations of stream sediments are higher than that of the parent rock [28]. The bedrock is composed of relatively few minerals, so the percentages of quartz and feldspar in all the sand are similar. Consequences of SAM diagram, most our samples generated from granitic components generated from Quaternary uplifting and dissection of the basement rocks. So it is quite sure that sand in this study area are almost derived from Jurassic biotite granite and Pre-Cambrian gneiss distributed in the Geum River Basin.

## Conclusion

Coarse sand is slightly predominated in floodplain compared in riverbed. It is presumed that the floodplain has a uniform bedloads in transporting process, while the present riverbeds are mixed with part of fine materials accumulated along the river dykes during waning period of flooding season. Materials finer than 0.075 mm of sand from the present riverbeds in the river dykes is richer than that of sand from the floodplain outside of the dykes. Density, absorption and soundness of sands from the floodplain are better than those of sands from the riverbeds. Chloride content of sand from the floodplain and riverbeds of the Gongju Geum River Basin is somewhat affected by human activity and high chloride content does not show any relation with the sea water. Greater density is generally related to finer grain size, but our experiments do not matched up with it. The disagreement derives from a coarser grain size, high density, high ratios of SiO2 and quartz concentrations of sands derived from the floodplain of the Gongju Geum River Basin. The major elements of sand between the floodplain and riverbeds are mostly in homogeneity. Among major elements, $SiO_2$ concentrations of sands from the floodplain are richer than that of sand from the riverbeds, especially. In view of the results from a SAM (silica-alkali-mafic) diagram, the sediments from the Geum River Basin are mostly identical and the sedimentary environments are relatively uncomplicated. Most of samples agree with D & E-type trend that is mainly derived from Jurassic Biotite Granite and Pre-Cambrian Gneiss distributed in the vicinity of the Geum River Basin. The concentrations of Silica major oxide ($SiO_2$) are negatively correlated with other major oxides both in the floodplain sands and in the riverbed sands. This may indicate that riverbed sand is processed predominantly by fluvial sorting than weathering process. Mineralogical, geochemical and mechanical properties of the bedrock have a strong influence on the properties of sands either derived from floodplain or riverbed deposits of the Gongju Geum River Basin.

## Competing Interests

The authors declare that they have no competing interests.

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