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Global Heritage Stone Resource

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Abstract: A designation as a Global Heritage Stone Resource (GHSR) provides international recognition of a natural stone resource that has achieved important utilisation in human culture. Stones used for heritage construction and sculptural masterpieces, as well as in utilitarian (yet culturally important) applications, are obvious candidates for the GHSR designation. The GHSR designation is essentially a "world heritage" naming of a stone type. The benefits of the designation include legal definition of an historic stone type, prevention of stone resource depletion, and improved restoration of stone heritage. The GHSR designation may encourage developers of new stone materials to aspire to major projects, international exports, and hence new market opportunities.

The Heritage Stone Task Group (HSTG) was established by the International Union of Geological Sciences (IUGS). The HSTG is also a working party under the Building Stone and Ornamental Rocks Commission of the International Association of Engineering Geology and the Environment (IAEG C-10). The HSTG Board of Management was established in August 2012 at the 34th International Geological Congress. The board is supposed to approve GHSR nominations and promote the designation. Trial nominations are being prepared for Portland Stone and Welsh Slate in the United Kingdom and Podpeč Limestone in Slovenia.

In this paper the Hiroshima-type Granite (Cretaceous), the Koto Rhyolite (Paleogene) and Hakone Andesite (Quaternary), which are some of the most famous building stones for Japanese castles, are introduced as examples for potential GHSR designation. In East and Southeast Asia there will be many stone types with potential to be designated as GHSRs.

Keywords: Global Heritage Stone Resource, heritage building

INTRODUCTION

The Global Heritage Stone Resource (GHSR) designation provides international recognition of a natural stone resource that has achieved important historic utilisation in human culture. Stones used for sculptural masterpieces and in construction of buildings forming an important part of an area's cultural heritage are obvious candidates for the GHSR designation.

The GHSR designation is essentially a "world heritage" naming of a stone type and the benefits of the designation include legal definition of an historic stone type, prevention of stone resource depletion, and improved restoration of stone heritage. The GHSR designation may also encourage developers of new stone materials to aspire to major projects, international exports, and hence new market opportunities.

THE HERITAGE STONE TASK GROUP

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President (*ex officio* Chair IAEG C-10): Dr Björn Schouenborg (Swedish National Testing and Research Institute, SWEDEN)

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Member: Dr Brian R. Marker (Independent Consultant, UNITED KINGDOM)

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Table 1: Checklist for the "Global Heritage Stone Province" citation.

Formal Name for this proposed "Global Heritage Stone Province":
Origin of Name (optional):
Other Names: (This may include other names given to the designated province)
Area of Occurrence: (This specifies the geographic area where the designated province occurs)
List of constituent "Global Heritage Stone Resource" designations that are included within this designated Province: (This lists those stone types within the province for which a separate formal description as a designated 'Global Heritage Stone Resource' has been prepared)
List of other known constituent heritage stone types, not otherwise designated, with assessment of international/national/regional status that are also included within this designated Province: (This lists other heritage stone types having international, national or regional significance)
Geological Setting:(Information on geology that places the designated province in a wider geological perspective)
Unifying geological characteristics within this province: (Information on the geology that specifies the unifying geological features of heritage stone within the province)
Natural variation of geology within this province: (Information on any natural changes within the designated province)
Vulnerability: (This should assess the overall availability of stone types in the province for future use and the constraints on supply)
Historic Use and Geographic Area of Utilisation: (This should provide a brief summary statement on the historic and geographic use of the stone from the designated province)
Construction: (This should provide an exemplary list of the most significant use of specified stone from this province)
Principal Literature related to the Designated Stone Province: (list major scientific papers, books and popular literature dealing with the designated province)
Any other items:
Person(s)/ Organisation(s) making submission:
Date of Submission:

Trial nominations are being prepared for Portland Stone and Welsh Slate in the United Kingdom and Podpeč Limestone in Slovenia. Table 1 summarises the information called for in seeking citation as a Global Heritage Stone Province.

POSSIBLE GSRH EXAMPLES IN JAPAN: HISTORY AND GEOLOGY OF STONE WALLS OF SOME TYPICAL JAPANESE CASTLES

Osaka Castle

In 1583**,** Hideyoshi Toyotomi (1536-1598) began to construct Osaka Castle and the surrounding castle town which is the origin of modern Osaka City, southwest Japan. During his reign, he set up a central administrative network in Osaka, ended the century-long civil wars and established the Toyotomi Government. However, his administration lasted only 15 years and ended with his death. Furthermore, Osaka Castle and town were destroyed by fire in 1615 because of so-called "Osaka Summer War" in which Toyotomi's allied forces were defeated by Tokugawa's allied forces. Then the castle was reconstructed between 1620 and 1629 under the rule of the Tokugawa Shogunate.

Origin of the Osaka Castle stones

These mainly consist of Cretaceous granite which is widely distributed in southwest Japan, comprising the so-called Hiroshima-type granite, a mainly coarse-grained biotite granite.

The granite building stones, exceeding 500,000 in number, were gathered from various areas including mountainous regions such as the Rokko Mountains

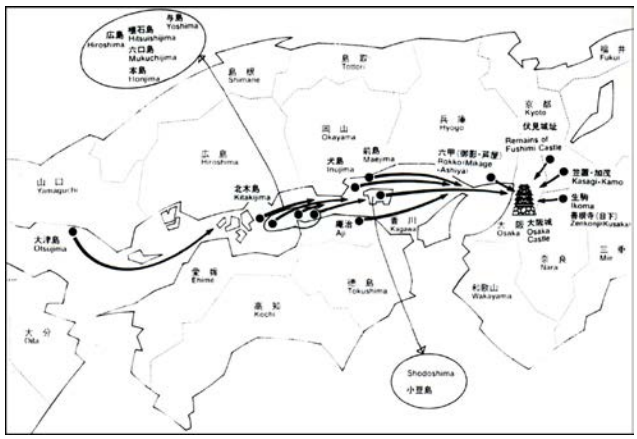

Figure 1: Origin of the granite used to construct the stone walls of Osaka Castle.

("Mikage", the local place name of the quarry in these mountains is a synonym of granite building stone in Japan.) and from islands of the Inland Sea (Setonaikai) (Figure 1). One can find seals or markings on the stone surfaces showing the origin and work areas assigned to the Daimyo, feudal lords, and also building information such as construction methods.

Giant stones of the walls of Osaka Castle

In the walls surrounding the courtyards of the gates of the castle are five stone blocks weighing over 100 tons and 16 blocks weighing more than 50 tons. The largest block is called "Tako-ishi" ("Tako" means octopus and "ishi" means stone in Japanese, Figure 2). Although the front surface of this stone is about 59.43 square meters and it weight is 108

Figure 2: "Tako-ishi"

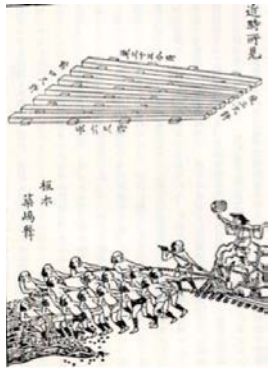

Figure 3: Transportation using "Shura".

Figure 4: Castle tower and base stone wall of Hikone Castle.

tons, its thickness is only 70 to 90 cm. This is because of the technical difficulty in cutting and transport (Figure 3) and because the builders wanted to have as wide a surface as possible. Almost all the stone blocks except these huge ones have a depth of between two or three times their width or height.

Hikone Castle

Hikone Castle with its twin moats and chalk-white walls is a hilltop-type castle and has for long been a landmark on the shores of Lake Biwa, the biggest lake in Japan (Figures 4 and 5). It is located in Hikone City, Shiga Prefecture, southwest Japan and is one of the four National Treasure Castles.

History of Hikone Castle

The victory of so-called "the Battle of Sekigahara" in 1600 between Tokugawa and Toyotomi allied forces is one of the most important events in the medieval history of Japan, because it founded the Edo (Tokugawa) Shogunate. On account of his contribution to the victory, Naomasa Ii, one of the Four Guardians of the Tokugawa, was given Sawayama Castle which was built at the beginning of the Kamakura Period (1192-1333) and became the first Lord of the Hikone Domain. His son and successor was permitted by the Tokugawa Shogunate to move the castle to Mt. Hikone because of its convenience and geopolitical importance. In 1604, he commenced the construction and transported much of the mountaintop Sawayama Castle's stonework and buildings and also the stonework of other nearby old castles so that it is often called "A Recycled Castle" (Figure 6). The castle was completed in 1622.

Geological setting of building stones

The main building stone is from the Koto Rhyolites formed during the igneous activity of the Koto Cauldron (Figures 10 and 11).

Edo Castle

Old Edo castle was built in 15th century. About 130 years later, Ieyasu Tokugawa who unified the nation completely, rebuilt the castle and developed Edo town, one of the

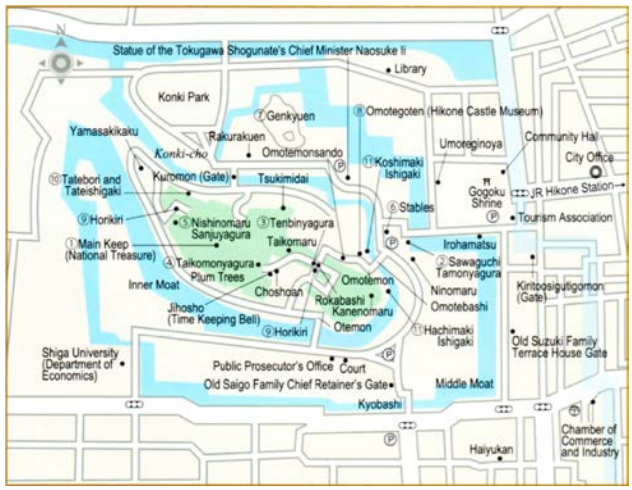

Figure 5: Locality map in and around Hikone Castle.

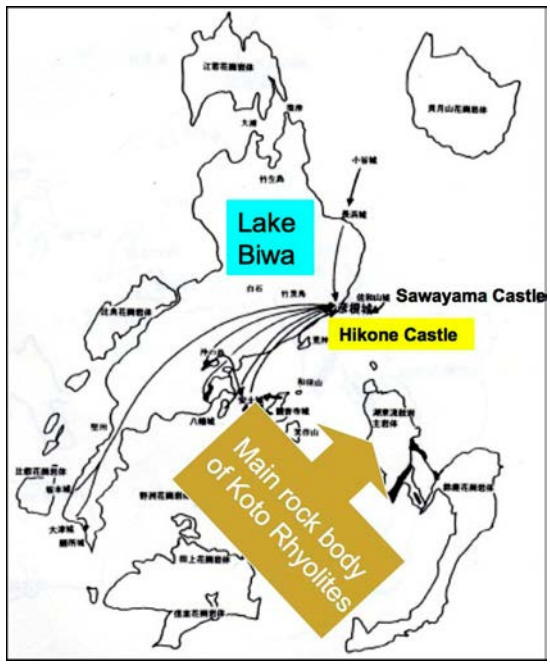

Figure 6: Origin of stones used in Hikone Castle. Many structures such as main keep, towers etc. were taken from other nearby castle because it was necessary to complete the castle as soon as possible in order to monitor the Toyotomi faction after the Battle of Sekigahara. The Hikone Castle stone was taken from the Late Cretaceous-Palaeogene Koto Rhyolite.

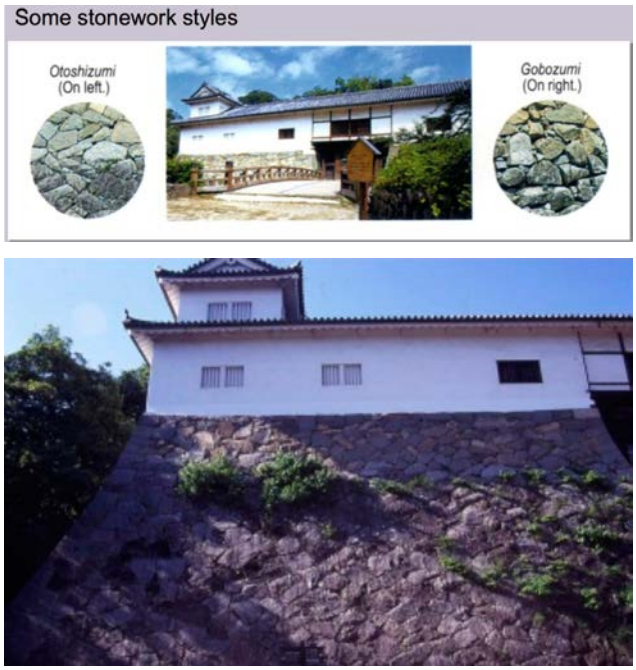

Figure 7: Stonework of Hikone Castle. Two-storied turret at the gates, which has been repaired many times, especially in 1854. The stone wall of right hand side was made in the original Gobozumi style of stone work. The left side was made by the later Otoshizumi style, because it was destroyed by the earthquake and re-built.

Figure 9: Inner Moat Stonework. Around the lower part of the earthen embankment known as Hachimaki Ishigaki ("Hachimaki" means headband) and Koshimaki Ishigaki ("Koshimaki" means waistband type underwear of women). This type of stonework is rarely seen in the Kansai region, southwest Japan.

biggest town in the world in those days. He enlarged the castle from 1604 to 1635. The castle is now used as the Imperial Palace.

Edo Castle stones

Mainly consisting of Quaternary andesite lava, the main quarrying places were several tens to more than 100 km away from Edo such as in Kanagawa and Shizuoka Prefectures.

Manazuru-misaki ("misaki" means peninsula in Japanese) is located 70 km southwestward from Tokyo (in Kanagawa Prefecture) and situated at the northeast end of Izu Peninsula, which is the northern end of Izu-Ogasawara Arc. In this area, Quaternary volcanic products are widely distributed and divided roughly into two groups, that is the Hakone Volcanoes comprising the Hakone Volcano (0.4 Ma to present) and Yugawara Volcano (0.4-0.2 Ma), and the slightly older Usami-Taga Volcanoes. These rock types

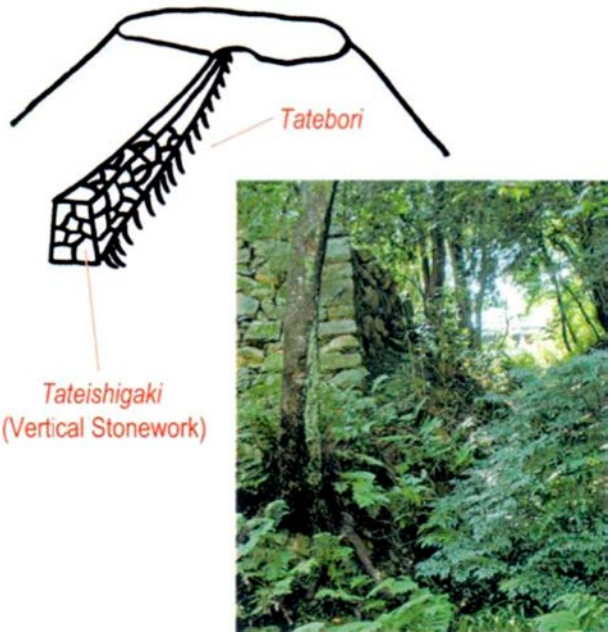

Figure 8: Vertical stoneworks, "Tate-ishigaki" in Japanese. "Tate" stands for vertical, and "ishigaki" is stonewall. Vertical stoneworks run from the top to the bottom of a hill to prevent an enemy attack. The top of the stonework is surrounded by a wall with tiles on top.

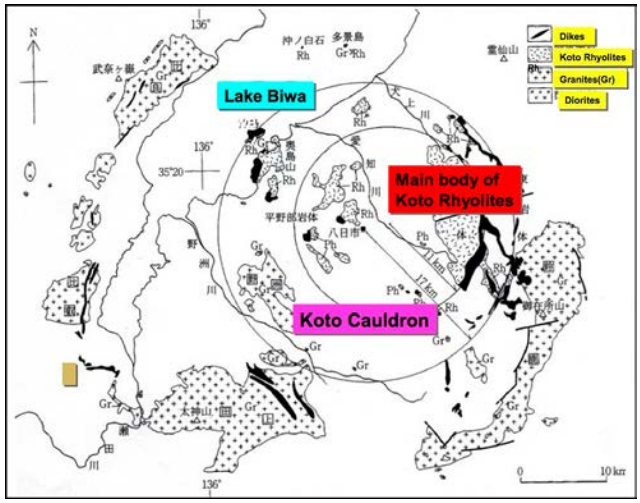

Figure 10: The Koto Rhyolites consist of welded tuff, pumiceous tuff, silicic pyroclastics including quartz porphyry of the latest Cretaceous to Plaeogene.

Figure 11: Outcrop and quarry of the Koto Rhyolite.

Figure 12: The keep (left) and stone wall (right) around the moat of Edo Castle.

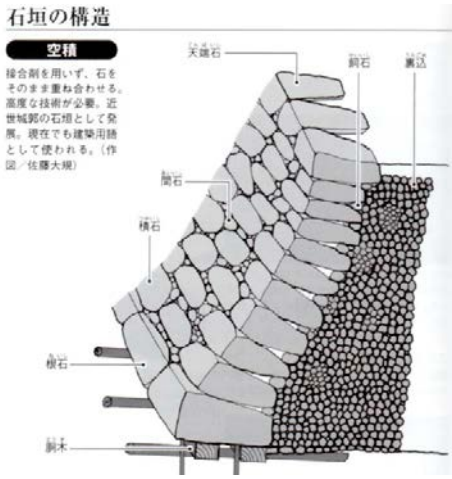

Figure 13: Structure of the stonewall.

Figure 14: Regular-cut blocks of the stonewall.

Figure 15: Manazuru-misaki Quarry.

Figure 16: Stamped stone block.

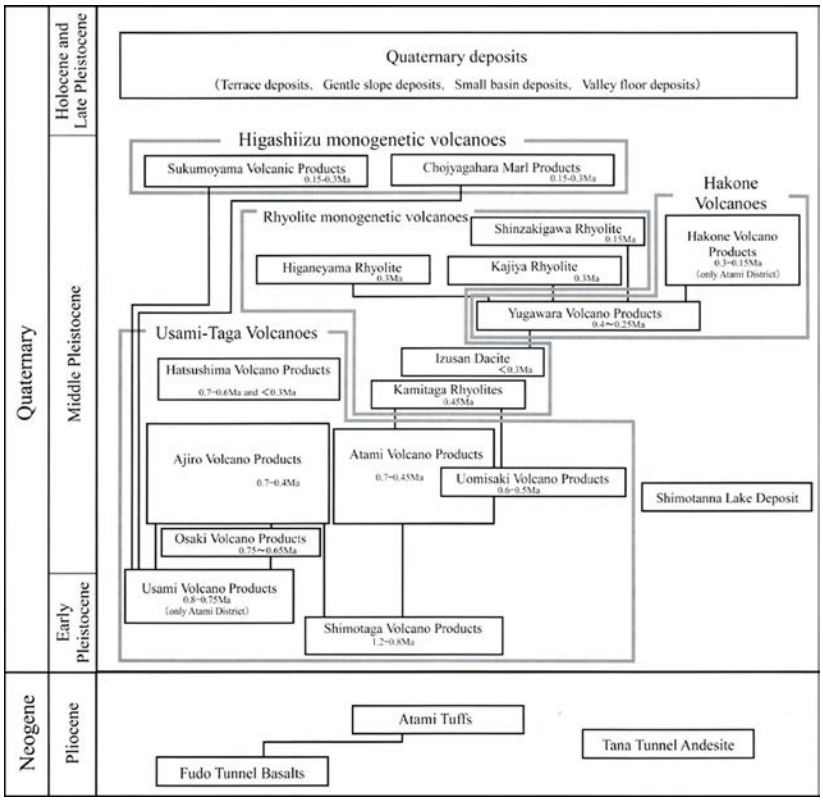

Figure 17: Summary of geology in the Atami area including Manazuru peninsula (Oikawa and Ishizuka, 2011).

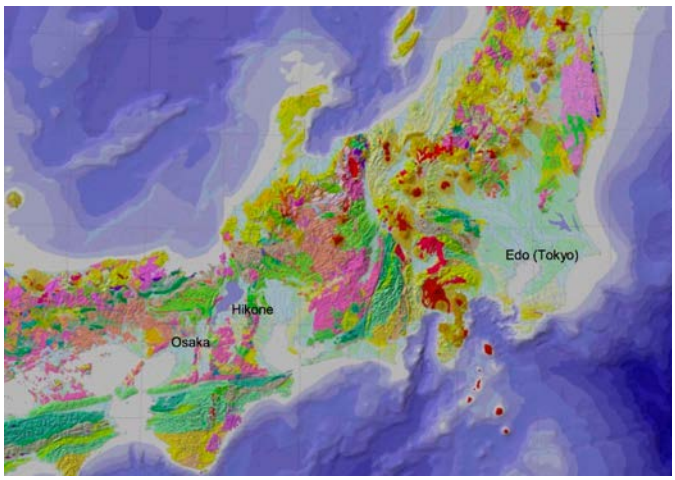

Figure 18: Index map of three castles.

are mainly olivine-clinopyroxene or olivine- clinopyroxene-orthopyroxene basalt to andesite, and clinopyroxene-orthopyroxene andesite to dacite. Some of them were used as building stones. The typical and famous usage of this stone was to build the stone walls of Edo Castle. Edo is the old name of Tokyo, the capital city of Japan. Edo Castle was built at the beginning of 17th century.

Hon-komatsu Lavas consisting of dacite lava whose K-Ar age is 0.18~0.17 Ma, 0.25 ±0.01 Ma, and Manazuru-misaki Lava consisting of andesite lava and pyroclastics whose K-Ar age is 0.15 ±0.01 Ma, are Hakone Volcanic products, dating from the Middle Pleistocene. Hon-komatsu Lavas are called Hon-komatsu-ishi as the name of building stone, and Manazuru-misaki Lava is called Shin-komatsu-ishi.

FURTHER COMMENT

In the near future, the author proposes to compile and edit a book, "Stone Heritage in East and Southeast Asia", in cooperation with relevant CCOP Member Countries.

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