Geochemical and Statistical Analysis of Heavy Metals and Elements in Tsunami Deposits at Coastal Areas of Northeastern Japan

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ABSTRACT

Huge amount of tsunami deposits remain after the large earthquake and tsunami occurred on March 11, 2011. This event may bring a possibility of environmental pollutions, particularly in the environment of soil and sediments around coastal areas of eastern Japan. Therefore a geochemical survey and investigation for soil contamination risk was carried out, to make clear the risk level caused by tsunami event and its deposits. Samples of tsunami deposits were analyzed by means of chemical and physical methods to accumulate the database for evaluating the environmental risk. Various kinds of tsunami deposits were observed at the coastal areas, some of them are sandy sediments and others are muddy with much clay components. The result of chemical analysis showed that some portions of deposits contain a little higher content of arsenic and lead, however, almost are similar component compared with normal subsurface soils. In the analysis of physical properties of deposits, a series of database was developed for particle distribution, soil and clay components, and content of organic matters. An approach of statistical analysis of elements in tsunami deposits was conducted by using an original technic of sparse modeling, in which the discrimination between tsunami deposits and normal marine stratum has been investigated.

KEY WORDS: tsunami deposits, statistical analysis, sparse modeling, risk assessment, heavy metals

INTRODUCTION

The earthquake on March 11, 2011 off the Pacific coast of northeastern Japan caused a lot of catastrophic damages of tsunami, flooding and liquefaction of land, and earthquake itself. Particularly terrible scale of waves hit coastal area with deformation and flooding of land. A series of tsunami attacked coastal area with deformation and flooding of land. A large amount of tsunami deposits and the resulting debris remained at tsunami suffered areas, which are still barrier from the reconstruction. However, if the sediments and soils are not contaminated, they will be able to utilize for agriculture and civil engineering activities. Urgent investigation during Mar. to Sep, 2011 was performed to investigate tsunami flooding areas from Aomori to Chiba prefecture and to identify various kinds of geological and geochemical evidences occurred by large tsunami attacks. As a result, it was found that tsunami deposits own a layering structure of several attacks in a couple of hours. The lands are covered by almost sandy sediments with some layers of silt or clay minerals, which have relatively higher content of organic substances and minerals. In addition, soils and sediments originated from tsunami contain relatively higher concentration of arsenic and lead elements, compared with natural background. This suggests that the sediments including toxic elements were transported from offshore marine muddy sediment with anaerobic environment. We continue to work for more detailed survey and geochemical analysis on the characteristics of tsunami deposits and soil contamination.

This paper reports the behavior of tsunami and its deposits at coastal areas of northeastern Japan, and the chemical components in tsunami deposits were investigated and analyzed on the basis of geological survey and chemical analysis of the samples. A statistical analysis of elements in tsunami deposits was conducted by using an original technique of sparse modeling, in which the discrimination between tsunami deposits and normal marine stratum can be achieved. In addition, a trial of environmental risk assessment of the situation from tsunami deposits on the offshore environment was performed by the various monitoring data. The countermeasures of risk mitigation were also discussed, regarding from the aspect of reconstruction using the materials of tsunami deposits.

GEOCHEMICAL FEATURES OF TSUNAMI DEPOSITS

Tsunami deposits widely observed at coastal areas at northeastern Japan were mainly originated from marine sediments caused by huge tsunami waves, because of evidences that they contain much amount of salt and organic matters. The deposits also contain a lot of contaminants and solid wastes of man-made items at urban areas where tsunami waves attacked from coastline to several kilometers onshore. So it is considered that the characteristics and components of the deposits were affected by those of marine sediments and subsurface soils.

Fig.1 shows one of the geochemical maps (Imai, 2010) made by Geological Survey of Japan. Authors have also developed the assessment maps for subsurface geology and soils (Hara, 2007), as showed in Fig.2. These geological maps are fundamental to evaluate the situation of sediments at coastal and terrestrial environment. To clarify the origin of tsunami deposits and the relation between coastal and terrestrial sediments, we have investigated the transport of...