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Active fault along the Kamishiro fault, Central Japan, Especially its close coincidence with the location of the surface

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Introduction

On November 22, 2014 at 10:08 PM local time, a JMA magnitude-6.7 earthquake (the 2014 Kamishiro fault earthquake) occurred in northern Nagano Prefecture, central Japan. The spatial distribution of aftershocks and the focal mechanism indicates that this earthquake was generated by movement along a reverse fault known as the Kamishiro fault - the northern part of the Itoigawa - Shizuoka Tectonic Line (ISTL) active fault system. Remarkable surface ruptures, over 9 km long, appeared along the Kamishiro fault. We have made public details about the nature and location of the Kamishiro fault before the earthquake on an active fault map (Matsuta et al, 2006; Research Group for ISTL Tectonic Landforms, 2007; http://danso.env.nagoya-u.ac.jp/istl-gis/). We wish to establish a location relationship between this surface rupture and the pre-existing active fault trace.

Re-examination of active fault maps of ISTL

Most of the 2014 surface ruptures appeared along pre-existing active fault traces. However, a very few surface ruptures appeared where there was no pre-existing active fault trace, prompting us to re-examine our former active fault maps. We looked again at a series of 1:10,000 aerial photographs archived in the 1940s and 1950s. The aerial photo analysis was supplemented and reinforced by field observations. Although the detailed re-interpretation of aerial photographs caused a few modifications of the locations of active fault traces, we concluded that the location of some active fault traces had not been added on former maps.

Implications for long-term earthquake prediction

The surface ruptures associated with the 2014 Kamishiro fault earthquake appeared in the area covered by a detailed active fault map (Matsuta et al, 2006; Research Group for ISTL Tectonic Landforms, 2007). Most of the 2014 surface ruptures appeared along pre-existing active fault traces shown on the maps. The proper maintenance of an active fault map contributes greatly to earthquake damage reduction. In this area, there have been three active fault maps apart from our map (Ikeda et al., 2002; Sawa et al., 1999; Togo et al., 1999). However, almost no back-thrust faulting associated with the main Kamishiro fault has been mapped on these three maps. The 2014 surface ruptures appeared along some back-thrust traces. It is important that we study small - less than 1 m - tectonic landforms, i.e., reverse tilting of the surface, flexural scarp, scarplet and back-thrust scarp. In the northern part of the ISTL active fault system (Hakuba Village to Matsumoto City, with a length of 55 km), the maximum vertical offset and a JMA magnitude during the last earthquake were estimated to be 5 - 6 m and MJMA 8.2 - 8.3, respectively (Suzuki et al., 2010). However, the maximum vertical offset during the 2014 Kamishiro fault earthquake is approximately one fifth as large as the above estimation. It could indicate that one-scale-smaller earthquake with MJMA -7 has been probably occurring with a shorter interval in the northern part of ISTL active fault system. Considering such a supposition, we need to re-evaluate a long-term earthquake prediction properly.

Keywords: the 2014 Kamishiro fault earthquake, Surface rupture, Active fault, Tectonic landform, Detailed active fault map