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Discussion

Reply to Discussion by Kayabali on "Attenuation relationship based on Turkish strong motion data and iso-acceleration map of Turkey" by Ulusay et al., Eng. Geol., 74:265–291 (2004). B

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We evaluated the comments raised by Kamil Kayabali on the paper by Ulusay et al. (2004). Here, you find below some explanations which we hope to clarify the criticisms he mentions.

Dr. Kayabali explains that examination of the peak motion data from the small number of normal-faulting earthquakes in the data set by Sadigh et al. (1997) indicated that they were not significantly different from peak motions from strike-slip earthquakes, and therefore, the normal and strike-slip earthquakes were combined into a single category in the attenuation relationship developed by these researchers. He also indicates that similar confirmations are also made by Douglas (2003), Aydan and Hasgür (1997), and Gülkan and Kalkan (2002) as also quoted by Ulusay et al. (2004). Based on these, Dr. Kayabali stresses that "Ulusay et al. (2004) themselves did not make any distinction between the type of faulting in the development of their attenuation relationship and it was not well understood why they criticize some other researchers for not taking into consideration of fault types". First of all, we should emphasize that our intent in the Introduction chapter of our paper (page 266) is not to make any criticism why the faulting type has not been considered in the previous studies. We only intended to give a brief summary on the parameters and/or approaches considered, and the equations employed in the previous studies. The statement quoted by Ulusay et al. (2004) is not a misinformation, because we know that the attenuation relation developed by Sadigh et al. (1997) does not suggest any constant to be used for normal-faulting, while it considers some constants for strike-slip, reverse and thrust faultings. However, these researchers consider the normal faulting in the category of strike-slip faulting. Based on the data from Turkish earthquakes, Aydan and Hasgür (1997) found relationships between the EW and NS compounds of the peak ground accelerations (PGA) for normal and strike-slip faultings. By considering these relationships, they concluded that the type of faulting seems to have less influence on the observed PGA values. However, they

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emphasize that this aspect should be further checked in the light of new data in the future. On the other hand, Abrahamson (2000) states that the standard practice is to use strike-slip attenuation relations to predict the ground motion from normal faults, however, the recent evaluations of normal faulting earthquakes indicate that the ground motions from normal-faulting earthquakes are smaller than for strike-slip earthquakes. Based on the above given information, influence of type of faulting on the measured PGA values is still open to discussion. However, in the development of the attenuation relationship by Ulusay et al. (2004) any distinction between the types of faulting is not made as it is also considered by Kayabali and Akin (2002). Therefore, we want to re-emphasize that our intent in the paper was only to make a characterization of status associated with the previous studies, not to criticize why the effect of normal-faulting has not been considered. We think that our explanations on this aspect given on page 266 of the paper were probably misunderstood by Dr. Kayabali.

Ulusay et al. (2004) indicate that although Aydan et al. (1996) suggest using the hypocentral distance as a distance measure in their attenuation equation, which has been developed based on Turkish earthquake data, Kayabali and Akin (2002) used epicentral distance instead of hypocentral distance when they employed Aydan et al.'s equation for comparison with some other attenuation relations. On the basis of this statement, Dr. Kayabali indicates that "the most earthscientists in Turkey concur that many epicentral distances of Anatolian earthquakes are not certain and in some cases the amount of error with respect to true location of an epicenter may be as large as several ten kilometers". Then he mentions that "from this point of view, the amount of error introduced into the calculation of the PGA by not accounting for the hypocentral distance using any attenuation relationship would be a marginal issue". As pointed out by Dr. Kayabali, some of the epicentral distances associated with Anatolian earthquakes may not be certain, as declared by various earthquake institutions. But it should be also kept in mind that accurate measures of focal depth are often difficult, and therefore, estimation of hypocentral distance is affected from this limitation as it can be seen in Fig. 3 of the paper by Ulusay et al. (2004). In addition, most damaging earthquakes occur within a shallow region of the crust and hence hypocentral distance and epicentral distance may become equal at intermediate and large distances. But the same conclusion may not be valid at limited distances; therefore, this situation should be remembered. Aydan slightly modified the form of his original attenuation relation (Aydan et al., 1996) in 2001 in order to satisfy the condition, that is, the maximum ground acceleration should be nil when the distance (R) goes to infinity, and applied the same function to stiff and rocky ground motion data by reducing the value of coefficient 2.8 to 0.56 (Eq. (3) on page 267 of the paper by Ulusay et al., 2004), which may be interpreted as the site condition. This modification was published in a Turkish journal (Aydan, 2001) and an international journal in English (Aydan et al., 2002). These publications (at least the one published in Turkish) have been omitted by Kayabali and Akin (2002) who used the 1996 version of the Aydan's equation in their work. We consider that the parameters appearing in any equation should be used without any change. In other words, if any attenuation equation requires using hypocentral distance, as being in the equation by Aydan, a different distance measure, such as epicentral distance should not be used instead. In such a case, any comparison among the various attenuation relations, which consider different distance measures, may result in misleading conclusions. Therefore, we considered to state this situation in our paper as a useful comment both for readers and the authors of the paper published in 2002. As it can also be seen from Figs. 7, 8, 9 10, 11 and 12 of the paper by Ulusay et al. (2004), the comparisons between some attenuation relationships are made by considering the different distance measures (showed by different symbols) they employ not to cause any misleading by readers. We do not believe in that we did not dominate the literature.

The other point to be addressed in the discussion by Dr. Kayabali is his explanations on the methodology employed by the study of Kayabali and Akin (2002). He indicates that the connection of fault segments in their work was made in consultation with the leading structural geologists in Turkey, and the logic behind in this choice is the creation of larger faults, which in turn results in higher magnitudes of earthquakes. In addition, he also mentions that this approach is useful to remain on the safe side to