Dear Editor,

We read the R.Rauld referee comments and include in the manuscript the discussions that he suggests. We thank to Rodrigo Rauld for his useful and constructive comments that improves the paper quality.

First we amend the specific comments one by one, and then the technical mistakes. The technical mistakes have the following logic:

Technical corrections #number, page and line:

Discussion manuscript: “Define whether or not the fault is active”

R.R comment: “Define whether or not the fault is seismically active.”

Correction/Explanation: “Define whether or not the fault is **seismically** active.”

All changes in the manuscript are note with bold letters.

1. Specific comments

Specific comment #1

The authors use several valid geophysical and geomorphological methods to evaluate the geometry in the fault in order to define segmentation. However, the manuscript lacks in detail about the assumptions they made or the data the use as a base for the analysis they carried out (There's no reference on the topographic data they used, neither the parameters considered about gravimetric measurements). So there is not traceability of results in these analyses.

Authors reply:

To improve this shortcoming we include the following sentences:

Page # 3 Line 1-3: "Basement morphology is a useful marker of cumulative faulting. Since SRF has a low slip rate, fault scarp morphology may be modified by deposit and/or erosion surface processes. Thus, we favor the use of gravity profiles and geomorphological measurements instead of scarp topographic analyses. **In order to carry out these methodologies we used a 30m resolution DEM (SRTM30, Farr et al. 2007).**"

Page # 5 Lines 22-27: "Density contrast between gravel material and basement rocks makes the gravity method a suitable tool to estimate basement geometry across the fault **(ρ_{sed} = 1950 kg/m^3; ρ_{sed} = 2600 kg/m^3 from Bosch (2015), consistent with the available values in literature *i.e* Telford et al. 1990)**. We did 24 gravity profiles across the SRF, with lengths of 2-3km. We used sampling distance of 100 m (in the fault core) and 200 m (at the flanks), and distance between profiles of 3-8 km (see profiles location in Fig. 6). **To avoid measurement errors, we eliminated the data with vertical position error over 30cm. The mean of the elevation error is 9cm with a standard deviation of 7cm (0.027 ± 0.022 mGal error in free air gravity correction).**

Specific comments #2

The authors must discuss in detail their results regarding those of previous works in the area, in this case they are not discussing, nor contrasting, the results of PGA they obtained assuming a rupture in a segment of the fault with those obtained by Pérez et al. (2014) assuming the worst case scenario. Since both results are numerically similar but are results of different cases.

Authors reply:

This is an important point that deserves to be included in discussion, so we add a sub-section in the discussion to analyze the PGA result itself and comparing with previous works.

Page #12 Line 6:

5.4 PGA results

The PGA modeling results are similar to the empirical PGA observed in others reverse earthquake. Examples of these are the Niigata Mw=6.6, 2004 Japan earthquake (Mori &

Somerville, 2006); Northridge Mw=6.7 1994 California earthquake (Porcella et al. 1994); Iwate-Miyagi Nairiku Mw=6.9 2008 Japan earthquake (Cultrera et al. 2013), all with near-epicenter recording stations. The similar PGA suggests that the approximation used in this work is consistent with the empirical evidence.

The range of the PGA values modeled in this work, PGA > 0.3g at distances shorter than 10 km from the fault scarp, are similar to the previous work made at the SRF (Perez et al. 2014) up to 0.2g in the nearby 10km from the fault. Largest values are also similar, PGA = 0.7-0.8g (Perez et al. 2014) and 0.8g in this work. The difference between both results stands on the PGA distribution. In our work we considered the amplification due to sedimentary cover, concentrating larger PGA values at the hanging walls cover by sediments. Whereas in Perez et al. (2014) focus on directional effects, concentrating larger PGA values at the southward fault zone, but neglecting site effects. We are not including directional effects due the lack of reliable focal mechanics.

Despite the differences in the maximum earthquake, Mw=6.9 in the case of Perez et al. (2014) and Mw=6.6-6.7 in our work, the range of PGA values are similar. In addition the largest PGA expected in both studies reaches up to 0.7g, a quite large number that confirm the potential hazardous at the near-field of SRF. As well as occur in faults that caused the Niigata and Northridge earthquakes.

Specific comment # 3

The authors must present the location of TEM profile in a figure, in order to pinpoint the spatial relation between SRF and the profile.

Authors reply:

We add a supplement figure to precise the position of the TEM profile. See Figure S1.

Specific comment # 4

There is no consensus about the concept of a fault's activity. Nevertheless, it is usually understood as the possibility of a fault causing an earthquake in the future. A fault is usually considered active if it presents evidence of displacements during the Holocene. As a suggestion, the authors could be more specific when stating the kind of activity they are discussing about the San Ramón fault, considering the fact that if the fault does not present seismic activity is not enough evidence to state the fault is not active. And several previous works states that the fault is geologically active. For a further discussion on this topic, the following authors and works could be considered if they are willing to discuss it: Burbank, D.; Anderson, R. (2012). Tectonic Geomorphology. Blackwell Science. McCalpin, J. P. (2009). Paleoseismology (2nd ed.). San Diego: Elsevier. PMA. (2008). Atlas de deformaciones cuaternarias de los Andes. Publicación Geológica Multinacional, No 7. Proyecto Multinacional Andino: Geociencias para las Comunidades Andinas. Servicio Nacional de

Geología y Minería. Wallace, R.E. (1986). Active tectonics: studies in Geophysics. National Academy of Science. Washington. Yeats, R.S.; Sieh, K.; Allen, C.R. 1997. The geology of earthquakes. Oxford University Press: p. 499. New York.

Authors reply:

We are aware about the lack of consensus regarding the concept of active fault, mainly because the ambiguity and subjective definition of what is a prudent time-lapse from the last earthquake. However we avoid to get involved in this discussion for its complexity and because is not the objective of this work, but we use the common senses of the concept that states: any fault with the probability to develop an earthquake in the near future is considered active (as well the referee mentioned: "*it is usually understood as the possibility of a fault causing an earthquake in the future")*.

In addition we agree with R.Rauld about the "*the fact that if the fault does not present seismic activity is not enough evidence to state the fault is not active".* However, our results demonstrate the presence of micro-seismic events at the fault vicinity, proof of the releasing tectonic energy spatially associated with the SRF. This evidence suggests that the SRF is indeed an active fault. This argument is consistent with the geological evidence of the fault activity, found in previous works (Armijo et al. 2010, Rauld, 2011, Vargas et al. 2014).

Specific comment #5

Both tectonic activity and the deformation produced by a fault are concepts associated to an observation or measurement which refers to a certain period of time. In the case of this article in particular this last time variable remains undiscussed and so the results are valid only for a fixed impression of the phenomena it observes and cannot be associated to a measurement of deformation rates.

Authors reply:

We agree with comment, but in any section of the paper we intend to approximate a precise deformation rate, because the methodologies applied involve several, but undetermined number, of seismic cycles. Besides, the observation time-window is not well constraint. Therefore, our approach is just a qualitative approximation of the fault phenomena behavior. A possible way to precise a deformation rate requires deposition and erosion rates that are beyond the scope of this work.

2. Technical corrections

Technical corrections #1 Page 3 Line 18:

Discussion manuscript: "These volcano-sedimentary sequences are mainly constituted by pyroclastic strata, interdigitated with lava and different sedimentary rocks."

R.R comment: "Are they? Refer to Thiele (1980) and references therein. Farellones Fm. are predominantly composed by lavas."

Correction: "These volcano-sedimentary sequences are constituted by pyroclastic **and lavas** strata, interdigitated with different sedimentary rocks." The last sentence is more specific with both geological units, the original sentence was describing mainly de Abanico Formation.

Technical corrections #2 Page 3 Line 28:

Discussion manuscript: "and to a lesser extent, pyroclastic ash related to the Maipo volcano eruption ~450.000 years ago (Stern et al., 1984)."

R.R comment: "In western and southern area of the study."

Correction: "and to a lesser extent in **the western and southern area of the study**, pyroclastic ash related to the Maipo volcano eruption ~450.000 years ago (Stern et al., 1984).

Technical corrections #3 Page 4 Line 10:

Discussion manuscript: "Until now, the seismic hazard analysis has only considered this worse-case-scenario (Pérez 10 et al., 2014), neglecting the likelihood of other intermediate options."

R.R comment: "This work must compare its results with those from Pérez et al. (2014). This is the unique mention of that work in all the manuscript. Since both works reach similar results, considering ground acceleration, they must be discussed and confronted in depth.".

Correction: See specific correction #2.

Technical corrections #4 Page 4 Line 25:

Discussion manuscript: "Given the SRF surface trace we project its potential extension downwards (Wells & Coppersmith, 1994)."

R.R comment: "using the empirical relations proposed by Wells and Coppersmith (1994)."

Correction: "Given the SRF surface trace we project its potential extension downwards **using an empirical relation (Wells & Coppersmith, 1994)**."

Technical corrections #5 Page 4 Line 26:

Correction: See specific correction #4.

Technical corrections #6 Page 4 Line 29:

Discussion manuscript: "Comparing the amount of events related to the fault, with those from other structures"

R.R comment: "Which ones? This statement needs evidence.".

Correction/Explanation: The study area has a huge amount of tectonics structures. To clarify, some examples are the structure associated with "Santa-Rosa cluster" (R.Rauld 2011), El Diablo thrust and Chacayes back-trust (Farias et al. 2008), unnamed faults that fold the Abanico and Farellones units (Armijo et al. 2010).

We add: Page 4 Line 30 "it can be discussed the importance of the fault in the stress release of the whole zone. **Examples of other structures in the study area are the El Diablo thrust and Chacayes back-thrust (Farias et al. 2008), the unnamed faults that fold the Abanico and Farellones units (Armijo et al., 2010, Rauld, 2011), and the structure associated with the "Santa-Rosa cluster" (Leyton et al. 2009).**

Technical corrections #7 Page 5 Line 1:

Correction: See specific correction #3.

Technical corrections #8 Page 5 Line 22:

Correction: See specific correction #1.

Technical corrections #9 Page 5 Line 29:

Correction: See specific correction #1.

Technical corrections #10 Page 6 Line 14:

Discussion manuscript: "In zones where the fault has not been previously mapped, we propose a straight trace parallel to the mountain front."

R.R comment: "Is this criteria valid? Which segments where defined using this criteria?"

Explanation: Based on the piedmont characteristic of the SRF, it is a valid first order criteria. See fault in the central area Figure 1. The segments where in the northern and southern zones of the study, see green line fault in Figure 1.

Technical corrections #11 Page 7 Line 26:

Discussion manuscript: "In terms of the fault geometry, this geoelectrical imaging represents a family of nearly vertical low/high resistivity bodies, interpreted as a system of high angle faults reaching the surface."

R.R comment: "In fact, there are several secondary faults exposed in the area. One of those is the one depicted as the SRF in the outcrop diagram in Figure 4."

Correction: This is not a correction, but reaffirms the results.

Technical corrections #12 Page 9 Line 5:

Discussion manuscript: "Fluctuating SI values indicate the occurrence of different geomorphologic processes dominating the fault scarp at the surface.".

R.R comment: "This sentence needs to be supported by a referenced example."

Correction: "Fluctuating SI values indicate the occurrence of different geomorphologic processes dominating the fault scarp at the surface **(i.e. Burbank & Anderson, 2001; Jain & Verma, 2006; Casa et al. 2010).**".

Technical corrections #13 Page 10 Line 10:

Discussion manuscript: "This denotes that the San Ramón fault is not necessarily the most important structure in the deforming cordillera."

R.R comment: "This sentence needs to be supported by some evidence."

Explanation: The evidence is describe before: "The natural seismicity distribution in the study area indicates that just five events can be related to SRF, representing 12% of the 41 well localized events, and 5% of all 110 crustal events regardless of their location error (but still within the area of interest)." We also change the sentence to "This denotes that the San Ramón fault **is not the only-one structure** in the deforming cordillera."

Technical corrections #14 Page 10 Line 23:

Discussion manuscript: "At depth, the micro-seismic study is also consistent with a high angle fault; therefore the dip angle of SRF is estimated at 65 degrees."

R.R comment: "Authors must discuss if this results are in agreement with the geometry of the fault proposed in previous works".

Explanation: The previous work shows a high angle fault in the shallower part of the fault (~50-60°Armijo et al. 2010). At the depth part they modeled a basal detachment with a 4.5° eastward dip, with uncertain depth but deeper than 10 km (Armijo et al. 2010). Given these difference angles, we model only the shallower part of the SRF as an independent system with the supposed basal detachment. Is important to mentioned that the basal detachment is under discussion, mainly by the differences evidence capable to confirms the eastward, or westward dipping (Farias et al. 2010, Armijo et al. 2010). As this matter can me extensively discus, we prefer to concentrate in our evidences that are consistent with the high angle fault based in the shallower observation of both models.

Also we add:

"At depth, the micro-seismic study is also consistent with a high angle fault; therefore the dip angle of SRF is estimated at 65 degrees. **Consistent with the folds axial planes eastward from the SRF (Rauld, 2011), see Figure 3b.**"

Technical corrections #15 Page 10 Line 25:

Discussion manuscript: “5.3 FSR segmentation”.

R.R comment: “This segmentation proposed by the authors must be discussed regarding the segmentation proposed by previous works”.

Correction: We add in Page#11 Line 17 the following sentence: “Based on the arguments listed previously our first order approximation states that segments 2, 3 and 4 behave as independent ruptures, where each one can generate a similar characteristic earthquake. **In addition the segmentation defined in this work is similar in a first order approximation with the defined in a previous work using a topographic analysis (Rauld, 2011).”**

Technical corrections #16 Page 12 Line 4:

Discussion manuscript: “our evidences consistently favor the occurrence of a single segment characteristic earthquake, with a rupture length of ~ 10 km.”

R.R comment: “This should be briefly explained here.”

Explanation: We think that, with the Figure 9 and the description developed in the beginning of the section that ends with the sentence commented, is enough to understand the idea (Page #10 Line 25 to Page #11 Line 15).

Technical corrections #17 Page 12 Line 14:

Correction: See specific correction #2.

Technical corrections #18 Page 12 Line 24:

Discussion manuscript: “Finally, the possible surface rupture of the SRF implies the highest collapse risk because the constructions are made to resist no more than 1% of differential settlements.”

R.R comment: “This sentence needs evidence.”

Correction/Explanation: The possible surface rupture of the SRF is discussed in section 5.2, Page #10 Line 18: “Another relevant variable is the shallow depth of the rupture (Youngs et al. 1997; Chiou & Youngs 2008). In SRF case, the quaternary sediments in the Calán hill are cut by the fault. Consistent with this observation, TEM results indicate that basement displacement is also reaching the basement roof (Fig. 4), and thus, breaking the surface.”

Beside we add the reference of the 1% of differential settlements: “Finally, the possible surface rupture of the SRF implies the highest collapse risk because the constructions are made to resist no more than 1% of differential settlements **(Skempton & Macdonald, 1956)**.”

Technical corrections #19 Page 13 Line 3:

Discussion manuscript: **“**Conclusion”

R.R comment: “Conclusions”

Correction: "Conclusions"

Technical corrections #20 Page 13 Line 25:

Discussion manuscript: **"**Reference"

R.R comment: "References"

Correction: "References"

Technical corrections #21 Page 16 Line 24:

Discussion manuscript: "Thiele, R.: Hoja de Santiago, Región Metropolitana. Carta Geológica de Chile, 39, 51, 1980."

R.R comment: "Editor: Servicio Nacional de Geología y MineríaCity: Santiago"

Correction: "Thiele, R.: Hoja de Santiago, Región Metropolitana. Carta Geológica de Chile, 39, 51. Servicio Nacional de Geología y Minería City: Santiago, 1980.

Technical corrections #22 Page 18 Line 2:

Discussion manuscript: "Figure 1. Geological map of the zone (Thiele 1980; Fernández 2003)."

R.R comment: "The caption should be more detailed, consider giving a description briefly explaining every element of the figure, and the nature of each geologic element.
What does it means "Volcano-Sedimentary (K)"?".

Correction: The main explanation of the units can be read in the text (section 2. Geological settings). Since this section will be near to the figure we do not change the figure caption, only add the Cretaceous word in the figure legend.

Technical corrections #23 Page 19 Line 1:

Discussion manuscript: "Define whether or not the fault is active"

R.R comment: "Define whether or not the fault is seismically active."

Correction: "Define whether or not the fault is **seismically** active."

Technical corrections #24 Page 19 Line 2:

Discussion manuscript: "Figure 2. Scheme of objectives and methodologies used in this work. In yellow the final objective."

R.R comment: "Consider giving more detail of every element of the figure in the caption."

Correction: We think that all objectives and methodologies are explain itself. In addition, this scheme will be near to a text explanation.

Technical corrections #25 Page 20 Line 2:

Discussion manuscript: “Figure 3. Microseismic study results. In the left panel, the map with epicenters of the recorded events, the color means depth of the hypocenter. In white the event with localization errors larger than 8km. The red rectangle represents the 70° projection plane on surface, and the blue rectangle the corresponding 30° projected plane. The right panel shows the seismic profile with well recorded events (depth error bands in green). The poorly localized events are indicated without error bars. The red and blue lines represent the planes of 70° and 30° respectively. The dashed black 5 line represents the interpretation of the SRF.”

R.R comment: “In left panel there are white inverted arrowheads. Are those representing the seismometers? They must be explained in figure caption."

Correction: “Figure 3. Microseismic study results. In the left panel, the map with epicenters of the recorded events, the color means depth of the hypocenter. In white the event with localization errors larger than 8km. **White inverted triangles are the seismic station**. The red rectangle represents the 70° projection plane on surface, and the blue rectangle the corresponding 30° projected plane. The right panel shows the seismic profile with well recorded events (depth error bands in green). The poorly localized events are indicated without error bars. The red and blue lines represent the planes of 70° and 30° respectively. The dashed black 5 line represents the interpretation of the SRF.”

Technical corrections #26, #27 and #28 Page 21:

R.R comment #26: “Consider to flip the upper panels in order to make them consistent with the orientation or at least try making coincide east and west. It appears like”.

R.R comment #27: “This panel gives the idea that the outcrop is facing south, while the outcrop is actually facing north. The extent, and the position, of the outcrop must be shown on the upper panels. Must correct”.

R.R comment #28: “In this figure the orientation of panels are confusing this must be corrected. This figure needs more work to allow the reader to observe how the elements are related and how the outcrop information supports the TEM interpretation.”

Explanation: We decided to keep the panel figure order, because they have an internal consistency with all the other figures that show the West to the right and the East to the left.

The TEM profile is independent of the outcrop at the SRF, mainly because the fault plane is interpreted as a conductivity body at basement depths, in contrast to the sediments deformation observed at the Calan hill outcrop. Thus both observations share the high angle fault interpretation that point to the same geological process, as is being widely discussed in the text.

Technical corrections #29 Page 22:

Discussion manuscript: “anoamly”.

R.R comment: “anomaly not anoamly”.

Correction: accepted.

Technical corrections #30 Page 22 Line 2:

Discussion manuscript: "Figure 5. In the upper panel the results of gravity inversion of profile 7. In the elevation profile the observed surface scarp is drawn (Rauld 2011). The regional tendency is calculated by a first order approximation. In the inverse profile the red arrow 5 shows the interpreted faults scarp. In the lower panel, the results of profiles 3 to 10 in planar view.".

R.R comment: "If the figure has some vertical exaggeration it must be quantified and explicitly stated in the figure."

Correction: "Figure 5. In the upper panel the results of gravity inversion of profile 7. In the elevation profile the observed surface scarp is drawn (Rauld 2011). The regional tendency is calculated by a first order approximation. The inverse profile **with a vertical exaggeration of x14,** the red arrow 5 shows the interpreted faults scarp. In the lower panel, the results of profiles 3 to 10 in planar view.".

Technical corrections #31 Page 23:

Discussion manuscript: Degrees of the figure 6.

R.R comment: "These labels are too close to the map, they are not easily readable.".

Correction: accepted.

Technical corrections #32 Page 23:

Discussion manuscript: Figure 6 coordinates.

R.R comment: "Consider avoid using UTM coordinates and geographical coordinates in different elements, otherwise they must be related explicitly in order to show a spatial correspondence between those elements.".

Correction: We add a text in the Figure caption to explain that they are in the same N-S scale. "Figure 6. Gravity profiles results. In the left panel the gravity profiles inversion. The green points represent the observed basement scarp. In the middle panel the gravity results in planar view. This view allows the fault continuity interpretation. The right panel shows the slip accumulated in each profile in red line, and the interpreted fault segments in different colors. **The N-S scale of the middle and right panel are the same.**".

Technical corrections #33 and # 34 Page 23:

Discussion manuscript: Arrows in the right panel of the Figure 6.

R.R comment: "Is not clear where this arrow are pointing to.".

Correction: We change the Figure 6, it can be observed in the new manuscript.

Technical corrections #34 Page 23:

Discussion manuscript: In the Figure caption: “This view allows the fault continuity interpretation.”.

R.R comment: “This statement must be explained in detail.”

Correction: “This view allows the fault continuity interpretation **connecting the near spatially related basement scarps.**”.

Technical corrections #35 Page 25:

Discussion manuscript: “Figure 8. Sinuosity Index results, in white the SI values.”

R.R comment: “Consider giving a more detailed explanation in this caption. (What is the background?, Is "seg" a segment?, etc.)”

Correction: “Figure 8. Sinuosity Index results. In white the SI values, **associated to a specific part of the fault named as a segment in this figure. Is important to note that these segments do not necessary represent the segments of the fault, it just a discrete separation along the SRF related with changes of sinuosity in the mountain front. As a reference, the geological map of the zone (Figure 1) is included in the back.**”.

Technical corrections #36 Page 26:

R.R comment: “Refer to comments in Figure 6.”.

Correction: Also changed.

3. References of the reply:

Bosch, A.: *Profundidad del basamento de la cuenca de Santiago a través de un modelo de gravimetría y evaluación de su potencial geotérmico. Engineering Thesis*. Pontificia Universidad Católica de Chile, 2015.

Burbank, D. W., y Anderson, R. S. : *Tectonic Geomorphology: Second Edition*. Blackwell Science, Oxford, UK, 2001.

Cultrera, G., Ameri, G., Saraò, A., Cirella, A., & Emolo, A.: Ground-motion simulations within ShakeMap methodology: application to the 2008 Iwate-Miyagi Nairiku (Japan) and 1980 Irpinia (Italy) earthquakes. *Geophys. J. Int. 193 (1)*, 220-237, 2013.

Farr, T. G., et al.: The Shuttle Radar Topography Mission, *Rev. Geophys., 45*, RG2004, 2007.

Leyton, F., Pérez, A., Campos, J., Rauld, R., y Kausel, E.:Anomalous seismicity in the lower crust of the Santiago Basin, Chile. *Physics of the Earth and Planetary Interiors*, *175*(1-2), 17–25, 2009.

Mori J. & Somerville, P.: Seismology and Strong Ground Motions in the 2004 Niigata Ken Chuetsu, Japan, Earthquake. *Earthquake Spectra, (22) S1*, S9–S21, 2006.

Porcella, R., Etheredge, E., Maley, R., Acosta, V.: Accelerograms recorded at USGS national strong-motion network station during the Ms=6.6 Northrige, California earthquake of January 17, 1994. *Open file report 94-141*. U.S. Geological survey, 1994.

Skempton, A.W., & Macdonald, D.H.: “The Allowable Settlement of Buildings”, *Proc. I.C.E. London, Part 3*, 727-784, 1956.