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Earth Surface Dynamics Discussions

Interactive comment on "Multiple controls on sediment grain properties of Peruvian coastal river basins" *by* Camille Litty et al.

Anonymous Referee #2

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In this paper, the authors present a large sedimentological dataset from rivers draining the western Peruvian Andes, and attempt to find relationships between grain size/sphericity, and variables like latitude, climate, tectonic setting, runoff and catchment properties. The field data have been collected carefully, from well-chosen sites spanning an interesting part of the Andes, and I am sure there are interesting insights to be gained by studying this dataset. Unfortunately, the results, interpretations and conclusions of this paper are confusing and unconvincing for several reasons.

The authors rule out a tectonic control by simply stating that greater surface uplift rates should result in larger clast sizes. Why? The mechanism underpinning this assumption (e.g., enhanced landsliding as a result of incision, etc) is very important if you want to look for tectonic signals in sedimentological data.

The Methods section requires more information about where the grain size were collected. 'Along a highway' isn't very helpful – were the measurements made at equivalent locations in the longitudinal profiles of the catchments? If you want to compare measurements from one catchment to another, it's important to demonstrate that the data come from comparable sampling sites. It would also be helpful to know where the discharge data were collected in the catchments. I appreciate that the coordinates are listed in Table 1, but some description is needed about whether the discharge data represent equivalent points in the catchments; i.e., if one catchment is sampled at the mouth and another at the headwaters, how can a meaningful comparison be made?

I have some major criticisms of the results. Uncertainties are needed on the grain size percentiles, because the scatter in Fig. 3a is larger than the trends the authors interpret. The way the authors describe the grain size data from line 162 onwards implies a systematic variation from north to south, which is not really true. It should be clarified that the rates of grain size change from north to south refer to an average regression fitted to the data. The whole paragraph from line 171 is not really a description of results, and could be moved to the Discussion. However the final point (line 176) is very important and needs some explanation. Why are there catchments in the middle of the study area that apparently have much bigger grain size differences (only sand and no gravel) than the catchments examined in the paper? The authors are apparently aware of much larger grain size variability in the area but have ignored those catchments, and it is not clear to me why.

There are some issues with Fig. 3. The data in panel A are compressed to the bottom of the graph and half the plot isn't used – please expand the data so the reader can better see the trends (the annotations can go above the graph). In panel B, I am concerned that some of the data points are missing between 5-15 degrees latitude. Why are there only 6 points (compared to 11 in A)? Also, which percentile has been used to calculate the a/b ratio?

Next, it appears the coarsest grain sizes from the northern group of catchments are

being exported from the shorter catchments that only drain west of the western escarpment. Those with larger upstream reaches crossing the western escarpment have equivalent grain sizes to the southern catchments. This difference is quite apparent by comparing Figs 1 and 3, and may invalidate the north/south grouping of catchments.

The final part of the results contrasts Figs 5 and 6. The authors suggest that there are no correlations between grain size and the chosen parameters in Fig. 5, but that there are correlations when the catchments are grouped (Fig. 6). This isn't really a comparison, because the two figures are showing different things. I cannot tell how Fig. 5e and 5f would compare to Fig. 6 if the same normalisation was performed on discharge. Why was discharge normalised in Fig. 6a but not elsewhere in the paper? And why have the authors chosen those particular grain size percentiles and variables in Fig. 6? It seems they have simply plotted everything against everything else and shown two unrelated correlations that are not particularly convincing and do not test a particular hypothesis. I am confused about why the southern catchments should be characterised by comparing runoff normalised by area with D50, while the northern catchments should be characterised by their gradients as a function of D96.

The Discussion attempts to address some important questions about grain size patterns observed in river networks and how they might record various forcings. Unfortunately, it is inconclusive and unclear. The authors claim around line 219 that fluvial transport dominates the Majes basin – if so, why does the D50 not fine over a 100 km distance? In section 4.2, do the arguments here require that smaller rivers in smaller basins are moving coarser material? This needs to be clarified. For section 4.3, what is the actual difference in climate between the northern and southern domains? In Fig. 1c, apart from the wetter patch near Huaraz (which actually overlies a catchment exporting finer grain sizes!), the two areas look similar. I recommend the authors plot the runoff data and/or precipitation against latitude (following Fig. 3) if they want to argue there is a relationship here. They need to show that the two domains are actually different and that climate correlates with grain size if they want to make that argu-

ment. In section 4.4, the authors could clarify whether the smaller catchments in the northern group were glaciated as well, or only the larger ones? Because the coarsest data seems to only come from the smaller catchments, and this is an important difference that needs to be addressed. These smaller catchments also drain proportionately more of the Coastal Batholith, which might indicate an erodibility control on grain size. The arguments in this section are vague and undeveloped and jump from glaciers to lithology without offering any precise interpretations.

In summary, this paper presents an interesting set of field data from an interesting study area in the Andes where many good questions could be tested. However it does not develop a clear hypothesis, clear interpretations, or clear conclusions. The reader is left with an impression that most of the data show no correlations, but if you plot every variable against every other variable and divide up the dataset enough, eventually you will find some weak trends. We learn that particle sizes and sphericity might not be related to tectonics, and might be related to climate, or catchment size, or the internal dynamics of catchments and sediment supply processes, or could be related to lithology, or glaciers, or El Niño. The paper needs much clearer answers to more precise questions, but I do encourage the authors to take a fresh look at the data.

I have some minor comments that the authors might find helpful for future submissions:

- "Contrariwise" is an unusual word, and I recommend using something like "on the contrary" instead

- Refer to "El Niño", not "the El Niño" or "the El Niño effect" (it is not an effect). Also, on line 114 you equate El Niño with ENSO – they are not exactly the same thing. El Niño is one phase of ENSO and brings particular weather patterns, but ENSO refers to the overall oscillation between El Niño, neutral, and La Niña states in the tropical Pacific

- "Strong precipitation rate" implies a high intensity of precipitation, which is quite different to a greater overall amount of precipitation

- Lines 107-109. This is confusing – hot air cannot rise and is trapped against the foothills, but also cools at high altitude?

- Line 112. If you refer to Pisco, mark it on the map

- Line 143. The D96 is not the maximum particle size

- Line 183. This sentence makes a big claim and needs to be supported by some key citations

- Line 293. Is the fracture spacing 10-20cm? Because this is the particle size range. I'm sure fracture spacing sets the sizes of large boulders, but I'm not convinced this mechanism applies to pebbles

- Line 295. The authors state that abrasion makes particles more spherical, and then say it doesn't. Please clarify which it is

- Line 300. Yet the southernmost catchments in the southern grouping are very small, but show the roundest clasts. Is this not contradictory?

- Fig. 5. These axes should be reversed

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