Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AHW30-P10 Room:Convention Hall Time:May 22 18:15-19:30

Relationship between catchment scale and the spatial variability of stream discharge and chemistry

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We investigated whether the representative elementary area (REA) concept can be adopted in catchments with multiple geologies. REA was defined as a certain threshold size of catchment area above which spatial variability among small catchments becomes small and can be ignored. From the definition of REA, in the area above the size of REA, only some knowledge (minimum knowledge) of the underlying distributions is needed for continuum assumptions. For verifying the adoption of REA concept in meso-scale catchments with multiple geologies, we need to examine whether the spatial variability of discharge and chemistry can be explained by mixing based on geology percentages. We observed stream discharge at 65 points and water chemistry at 157 points in a 55 km^2 catchment that included multiple geologies. At observation points with uniform geology, stream chemistry became constant beyond about 1km^2 in granodiorite and volcanic rocks. The values to which stream chemistry converged were different between the two geologies. At observation points with multiple geologies, spatial variability remained large beyond a few square kilometers. SiO_2 and Mg^{2+} concentrations became constant above 10 km^2, but Ca^{2+} and electrical conductivity did not become constant until 55 km^2. Our calculation revealed that almost all observed variables were explained by mixture based on geological percentages, in 1-17km^2. However, above 17km^2, observed values were higher than calculated values. In regions with multiple geologies, the adoption of the REA concept with minimum parameter, geology, was confirmed at 1-17 km^2. However, above 17 km^2, our results indicated that the REA concept does not apply.

Keywords: spatial variability, stream water, catchment scale, water chemistry, bedrock geology, REA