Volcanic forcing from two sides: Drainage and plant ecosystem development in the Columbia River Flood Basalt Province, Washington State

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Large Igneous Province (LIP) volcanic activity has been implicated to have had significant environmental effects throughout Earth's history. However, the impact that LIP evolution has had on drainage and plant ecosystem development in the immediate vicinity of volcanic activity is poorly constrained. Here we present an integrative approach to better understand the relationships between LIP volcanic activity and inter-lava field drainage and plant ecosystem development in the Miocene Columbia River Basalt Province (CRBP), Washington State.

The CRBP stratigraphy comprises numerous basaltic lava flows which are intercalated with fluvio-lacustrine sediments formed during periods of volcanic quiescence. These interbed intervals become longer as volcanic activity wanes during CRBP LIP evolution. Detailed facies analysis of the sedimentary interbeds indicates intra-basaltic establishment of fluvial systems associated with various types of lacustrine and wetland settings. The distribution of sedimentary settings and pattern of drainage development is reflected in CRBP effusion frequency, and correlates with lava field topography and lava flow emplacement patterns.

The vegetation that inhabited the fluvio-lacustrine environment is expected to reflect drainage development and to become more mature during longer volcanic hiatuses. The palynological record of the sedimentary interbeds however shows that plant succession does not correlate with CRBP evolution. The analysis of pyroclastic deposits within the interbeds and sediment geochemical investigations suggest that plant succession in the CRBP was largely controlled by extrinsic volcanism of the Yellowstone hotspot.

While CRBP LIP evolution had significant impact on drainage system development and the distribution of sedimentary settings, it has less influence on the intra-basaltic plant ecosystem. Response of the CRBP palynoflora to Yellowstone hotspot volcanism demonstrates that intra-LIP vegetation may be largely controlled by extrinsic forces, and argues against global climate and environmental changes solely driven by LIP volcanism. Nevertheless, LIP parameters and dimensions vary between individual LIPs and may modify the magnitude of environmental impact.