The development of fluvial environments within volcanic terrains: the Miocene Columbia River Basalt Province (Washington State, USA) as a case study

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1. Introduction

The interplay between Large Igneous Province (LIP) volcanism and fluvial environments is not yet well understood, for which the Miocene Columbia River Basalt Province (CRBP) in Washington State, USA, offers exceptional study conditions. The CRBP comprises several extensive basaltic lava flows, which are intercalated with fluvial interbeds, and associated lacustrine and palaeosol environments.

2. Fluvial facies associations

Based on detailed lithofacies analysis the fluvial environments can be defined as sand-dominated channel facies, interbedded with gravel-dominated channel facies and mud-dominated overbank facies. The sand-dominated channel facies is characterised by single- to multi-storey sand bodies indicating a system of dunes, bars and channels. The gravel-dominated channel facies comprises mostly multi-storey and sheet-like conglomerate bodies, suggesting a network of gravel bars, gravel sheets and channels. Based on sedimentary facies analysis, the intra-basaltic drainage system development can be grouped into an early, middle and late stage evolution, which is strongly correlated with changes in volcanic activity during the LIP evolution.

3. Development of fluvial environments

The early stage CRBP evolution is indicated by high effusion rates and relatively short periods of volcanic quiescence. During this stage fluvial systems were dominated by a network of laterally migrating sand-dominated channels (up to 3.6 m deep), dunes, bars and muddy floodplains, which entered the lava field marginally. As the CRBP evolution succeeds and volcanic activity wanes river systems become larger in size (up to 6.5 m deep) and advance into the lava field centre (late stage of drainage evolution). The intercalation of sand- and gravel-dominated channel facies is common. Rivers floodplains further record significant ash input from fall out. At this stage the waning eruption rate causes longer periods of intra-volcanic sedimentation, providing more time for erosion, channel incision and progradation into the main area of volcanic activity.

4. Conclusions

These studies revealed that there is a close linkage between volcanism, lava flow emplacement and establishment of fluvial systems. As fluvial facies are the dominant sedimentary deposits within the CRBP stratigraphy, detailed studies on facies characteristics, distribution and evolution contribute greatly to the overall understanding of the CRBP drainage evolution, uplift and erosion and help to better understand sedimentation in LIP's in general.

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