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Landscape change on the SE Australian Tablelands in the Holocene: an updated chronology of gully incision and 'post-settlement' alluviation

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The specific causes and timing of gully incision into swampy meadows throughout the Tablelands of New South Wales, Australia, have been the focus of decades of discussion. Sediment eroded from these gullies is often deposited downstream and referred to as post-settlement alluvium (PSA) as European artefacts such as wire, cans, bottle, and cloth are often found buried in many of these deposits. However, the lack of quantitative data on the timing of gully erosion and subsequent PSA deposition leads to prolonged debate over causes of gully erosion and hampers our ability to understand the total impact of introduced land-use practices on a landscape. As sediment dating techniques such as optically stimulated luminescence (OSL) improve, so does the potential for understanding how and when the Tablelands evolved since the first European surveyors described the landscape. There are only a few applications of these techniques on the Tablelands, however, and they tend to focus on individual sites rather than analysing landscape change in a regional context. We test the commonly held notion that European land-use in the early 19th century caused gully erosion of valley-bottom soils and the associated downstream deposition of PSA on the Tablelands. Here, we present results from a portable OSL reader to identify multiple PSA deposits suitable for burial-age dating, demonstrating the feasibility of this increasingly-accessible field technique in identifying changes in environmental conditions during sediment deposition. Sediment deposited in low-energy swampy meadow environments tends to be well-bleached; the luminescence signal decreases toward zero at the ground surface in modern swampy meadows. After landscape disturbance there is an influx of unbleached sediment and a large (inherited) portable reader luminescence signal is observed in the lowest horizon of PSA deposits, stratigraphically younger than the swampy meadow sediments. This spike in the bulk luminescence up-profile at each site is a regional phenomenon. We demonstrate that changes in grain-size and mineralogy alone cannot explain the observed jump in the luminescence signal at the swampy meadow-PSA boundary, and we therefore suggest that we are observing a change in environmental conditions that prevents sediment from being fully bleached in transport before reburial as PSA. Two burial-age OSL samples were collected at six suitable sites: the first at the base of each PSA deposit and the second at the top of the underlying swampy meadow sediment. We determined burial-ages from these 12 samples using a single grain OSL methodology and calculated the burial age of PSA deposits using a minimum age model. These new data aid in our investigation of intrinsic and extrinsic factors that may have triggered gully incision at each of our sites and, in conjunction with existing data, illustrate a detailed regional chronology for Tablelands evolution over the last few centuries.