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AMS radiocarbon dating of pollen concentrates in a karstic lake system

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In lake sediments where terrestrial macrofossils are rare or absent, AMS radiocarbon dating of pollen concentrates represents an important alternative solution for developing a robust and high resolution chronology suitable for Bayesian modelling of age-depth relationships. Here we report an application of the dense media separation approach (Vandergoes and Prior, Radiocarbon 45:479-492, 2003) to Holocene lake sediments from karstic Lake Sidi Ali, Morocco (33° 03'N, 05° 00'W; 2,080 m a.s.l.). Paired dates on terrestrial (macrofossil) and aquatic (ostracod) samples, and dating of bulk sediment surface material at the site indicate varying reservoir effects of up to 900 yr and highlight the need to date terrestrial carbon sources. Dating of pollen concentrates is a viable approach at Lake Sidi Ali, as pollen concentrations are high (∼200,000 grains/cc), and pollen assemblages typically contain only minor percentages (<1%) of aquatic pollen. Following laboratory trials, 23 pollen concentrates alongside laboratory standards (anthracite, IAEA C5 wood) were prepared and dated following the heavy liquid (sodium polytungstate, SPT) density separation protocol. A series of SPT solutions of progressively decreasing density (1.9-1.15 s.g.) were used to divide the samples into several fractions. The pollen purity of these fractions was evaluated by microscopic analysis of smear slides, and the richest fraction(s) were selected for dating. Sieving at 10 μm and at 50/125 μm (depending on the size of predominant pollen grains) was used to further concentrate the pollen grains, and the samples were freeze dried to determine the dry weight of material. The results show that the highest purity of pollen is sample dependent and may typically be achieved in the fractions precipitating at 1.4-1.2 s.g. With sieving, terrestrial pollen purity of ∼50-80% can be achieved, offering a considerable improvement in terms of terrestrial carbon content over bulk sediment. These values reflect the challenge in some samples of fully separating pollen grains from common aquatic algae, e.g. Pediastrum and Botryococcus. From sediment samples of ∼15 g dry weight, it was possible to achieve pollen concentrates of 0.5-5 mg, with C content typically ∼50% by weight. Samples with as little as 70-200 μg C were successfully measured with 0.5-1% error on the 14C age determination. This application of the pollen concentrate dating approach reinforces the importance of microscopic inspection of the residues during the separation and sieving stages. Sample specific differences mean that the pollen concentrate preparation cannot be reduced to a simplistic "black box" protocol, and dating must be undertaken alongside detailed analysis of the microfossil content of the sediments.