Deficient electron microprobe totals: Discussion of potential causes

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Radiation-damaged minerals, including zircon, coffinite, thorite and monazite, are occasionally found to yield electron microprobe results whose totals (oxide sums) are deficient, i.e. appreciably below 100 wt%. Causes of the apparently too low totals are controversial; most authors have assigned the phenomenon to enhanced contents of hydrous species, other non-analyzed elements, textural peculiarities such as voids, or instability and degradation under the electron beam. It has also been observed that micro-areas yielding low totals are typically recognized from very low BSE intensities (Kempe *et al.*, 2000), which is in apparent contradiction to their usually high degree of radiation damage and the positive correlation between radiation damage and BSE intensiy (Nasdala *et al.*, 2006).

We have studied low-totals zircon from three localities. Deficient totals and accompanying very low BSE intensities are only detected in areas affected by secondary alteration whereas primary zircon never shows these phenomena. The alteration has often, but not always, led to enhanced actinide content, which is why low-totals areas are mostly radiation-damaged. Low-totals areas were found to contain up to 5 wt% hydrous species, which explains both the deficient analysis sums and the low BSE intensity (due to decrease of the average atomic number). In the TEM, low-totals areas show a sponge-like texture with numerous sub-micron sized voids, as it was suggested by Pointer *et al.* (1988). We explain the formation of this texture and the water uptake by secondary, fluid-driven alteration of previously radiation-damaged and thus volume-expanded zircon.

References

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