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$^{40}Ar/^{39}Ar$ and U-Pb geochronology of mafic and felsic magmatism in the South Atlantic

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Incremental-heating $^{40}Ar/^{39}Ar$ geochronology of mineral separates and whole-rock fragments has been instrumental in determining the ages of magmatic events associated with opening of the South Atlantic. These magmatic events are recorded in continental flood basalts, felsic volcanic units, mafic dyke swarms, and alkaline intrusions and lava flows, all precisely and accurately dated by $^{40}Ar/^{39}Ar$ incremental heating analyses or U-Pb geochronology. Some or all of these same magmatic events occur offshore in volcanic and sedimentary sequences in the South Atlantic. Therefore, in principle, it should be possible to date offshore magmatism and correlate it with continental intrusive and extrusive events. However, complex thermal histories and fluid circulation in the offshore sequences promote possible thermal resetting and hydrothermal alteration of the magmatic units, strongly affecting their $^{40}Ar/^{39}Ar$ systematics. Zircon U-Pb geochronology permits overcoming these difficulties, but the sizes of samples retrieved from offshore drilling (two-inch long, one-inch diameter sidewall cores) are not sufficiently large to ensure the easy recovery of magmatic zircons, even if the volcanic samples are suitable. In this study, we dated >400 whole-rock samples and mineral separates by laser incremental-heating $^{40}Ar/^{39}Ar$ analysis. We also dated zircon crystals in petrographic sections by in situ laser ablation MC-ICP-MS analysis. We complemented all geochronology results with optical and electron microscopy of fresh and altered igneous units, which permits determining if geochronology results reveal ages of volcanism or alteration events. The combination of high-resolution geochronological and mineralogical tools on single crystals and whole rocks permits determining at least six major magmatic events for the offshore volcanism in the South Atlantic: ~131, 129-127, 125-120, 117-114, 90-80 and 65-40 Ma. The results also reveal several pulses of hydrothermal alteration: 116-114, 109-100, 90-70, 60-65, 50-40, and possibly 30 Ma. Many of the alteration events on older igneous rocks are coeval with younger magmatic events, revealing the important role of magmatic heat in the circulation of fluids in the sedimentary basins, particularly in sub-salt sequences. The strong Na and K metasomatism detected in the hydrothermally altered volcanic units also reveals the importance of salt dissolution in increasing the reactivity of hydrothermal solutions.