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Present-day Arabian plate motion and implications for Arabia-Eurasia continental collision

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The separation of Arabia from Africa (Nubia) initiated in the Early Miocene roughly simultaneously with the onset of continental collision between Arabia and Eurasia along the Bitlis-Zagros suture zone. Collision continues today as evidenced by the intense seismic activity along the borders of the Arabian plate (particularly in the north and east). We initiated GPS observations in the Kingdom of Saudi Arabia in March 2002 to constrain better the present motion and internal deformation of the Arabian plate. Continuous GPS stations are currently operating near Riyadh (24.9N/46.4E), Jeddah (21.4N/39.6E), Halat Ammar (29.1N/36.1E), An Nimas (19.2N/42.1E), and Al Wajh (26.5N/36.4E). These stations, together with the IGS stations in Bahrain and Damascus, and survey sites in SE Turkey, Oman, and Yemen provide constraints on present-day Arabia Plate motion. The GPS velocities are consistent with coherent motion of the Arabian plate with internal deformation below the current resolution of our measurements ($\sim$ 1-2 mm/yr). The GPS-determined Euler vectors for Arabia-Nubia, and Arabia-Somalia relative motions are indistinguishable from geologic Euler vectors determined from marine magnetic anomalies in the Red Sea and Gulf of Aden reported by Chu and Gordon (1998, GJI, 135, 313-328; 1999, Nature, 398, 64-66). Furthermore, Arabia-Eurasia relative motion from GPS is equal within uncertainties to relative motion determined from plate reconstructions (McQuarrie et al., 2003, GRL, 30, GL017992) suggesting that Arabia plate motion has remained constant ($\pm$10%) during the past few Ma. The new constraints on Arabia motion provide corresponding strong constraints on slip rates for the faults bounding the plate, including the Dead Sea fault, Makran subduction, faults along the Zagros Mountains, and the East Anatolian Fault (EAF) that separates the Arabian and Anatolian plates. Surprisingly, we find that while the EAF is characterized by predominantly left-lateral strike slip,

it also shows a small component of extension. Likewise we find extension in the direction of relative plate motion north of the Arabian plate in the Lesser Caucasus. These observations appear to be incompatible with classic “indentor/extrusion” models for present-day deformation within continental collision zones. We discuss the implications of these observations for dynamic models of continental deformation in the Arabia-Eurasia collision zone.