MORE IMPACT AND IMPACT-LIKE STRUCTURES ON SIR-C RADAR; EUROPE, AFRICA, AND ARABIAN PENINSULA. *J.F. McHone[1] and R. Greeley[2], Dept.of Geology, Arizona State University, Tempe, AZ 85287-1404.*
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In April and again in October of 1994, the Spaceborne Radar Laboratory (**SRL**) was carried aloft on two separate missions aboard Space Shuttle *Endeavour*. The objective of these flights was to obtain high resolution multiwavelength and multipolarized (**SIR-C** & **X-SAR**) radar images of a wide variety of preselected ground targets including several known impact structures. Impact scars are a fundamental interplanetary landform and the characterization of terrestrial craterforms using remote sensors is pertinent to the study of all coherent bodies in space. Both missions were sucessful and preliminary descriptions of numerous crater images derived from radar data have been reported [1,2]. As analysis of the growing inventory of processed images continues, several additional sites of interest have been detected. These newly identified images are of either previously known or suspected impact features, or they are of landforms which have radar signatures resembling impact structures. This report suppliments previous findings with descriptions of images over Europe, Africa, and the Arabian Peninsula.

Koefels, Austria
47° 07'N; 010° 55'E 4 km dia.

Oetztal valley in the Austrian Alps was originally selected as a SIRC/X-SAR "Supersite" in order to obtain repeated spaceborne radar coverage of alpine glaciers and their relation to global climate changes. The Koefels structure lies within this study area and is widely regarded as a probable impact-generated feature [3]. It consists of a 4 km wide slump scar cut into the western wall of the Oetz River valley and a corresponding mass of fractured coherent rock and debris which partially dams the valley floor. Shock metamorphic features reported in components of this rock mass [4] have strenghtened the concept that the Koefels landslide event was triggered by meteoritic impact. On a radar scene generated during SRL-1, Data Take 78.00, Koefels is clearly imaged. Sides and upper ridge line of the slump scar are sharply defined by radar shadows and by slope effects along the valley wall. The terraced valley floor in the vicinity of the slump block is widened with thick, smooth-surfaced sediments which appear radar-dark compared to the radar-bright mass of fallen debris.

South Libya
21° 21'N; 020° 45'E 3 km dia.

Several SRL track lines covered the giant, 13 km-wide Aorounga impact structure in northern Chad [2,5] and then continue on through the northeastern Sahara. In Libya, about 40 km north of the border with Chad, one of these swaths (Data Take 140.10) recorded a single 3 km-wide radar-dark circular pattern located in a generally homogeneous, radar-bright area. This entire region is mapped as Cretaceous Nubian Sandstone [6]. A thin bright line of radar backscatter along the circle's downrange margin is here interpreted as a steep rock wall surrounding a smooth, sand-floored depression. Bright radar returns from surrounding flatlands are the result of a blocky residual surface typical of carbonate-bearing Nubian units. Although this depression could possibly be a paleokarst landform, an impact origin is supported by it's isolated nature.

Al Umchaimin, Iraq
32° 36'N; 039° 25' E 2.75 km dia.

The origin of 30 m deep Al Umchaimin crater in northwestern Iraq is still unsettled. Various authors have attributed its formation to solution, volcanic, or impact processes as summarized by Underwood [8]. Its prominant appearance on earlier, 1991 shuttle imaging radar (SIR-A, Data Take 7) has caught the attention of several investigators [7,8,9,10] who have classified it as a possible impact crater. No shock indicators have yet been reported in local rocks. However, the presence of an outer ring of slightly suppressed radar return and of a possible buried system of concentric annular drainage are indicated by newer, high resolution SRL data. These features are consistent with the former existence of thin ejecta deposites and of an outer topographic ramp which controlled

development of local drainage patterns during former times of more humid climate.

El-Mirba, Jordan
32° 42'N; 038° 52'E 10 km dia.

A second circular feature of presently unknown origin appears on the same SIR-C radar image as Al Umchaimin crater. Centered about 42 km to the northwest, it lies just across the Iraqi border in Jordan. On visible wavelength Landsat images, the structure is clearly highlighted by bright concetric arcs of white sand-filled drainage streams or wadis. The structure is less distinct on orbital radar which renders it a zone of radar-dark sediments covering the floor of Wadi el-Mirba [7]. Teilen-Willege detected the double ring on a 1975 Landsat image and on 1991 SIR-A radar data [10] and suggested the site was a complex impact structure named Treibel. Compared to the early SIR-A data, more recently acquired 1994 SIR-C data reveal a substantial increase in intense, man-made radar reflectors. Large concentrations of buildings, fences, and pipelines occur near the feature center and are associated with petroleum and/or military operations in this politically sensitive region.

Habhab, Oman
19° 55'N; 057° 00'E 6 km dia.

The 6 km wide Habhab feature is formed in Cretaceous marine deposits of the southern Omani desert. It was first reported as a possible impact structure when its distinct dark-ringed bulls eye pattern was detected on Landsat images [11]. Although impact generated shock features have not yet been reported, field examination and geophysical surveys [12,13] reveal the site to be a gentle, shallow-rooted dome structure encircled with concentric topographic depressions. At the time of the Landsat flyover, these depressions were covered by vigorous stands of desert grasses which, unlike the bright barren sand rings at El-Mirba in Jordan, appear darker than surrounding sedimentary rocks. The Habhab ring depressions also appear dark on SRL radar images (Figure 1). Microwave energy radiated from the orbiting spacecraft was either absorbed by sand-filled troughs or it was reflected into downrange space by their smooth flat surfaces.

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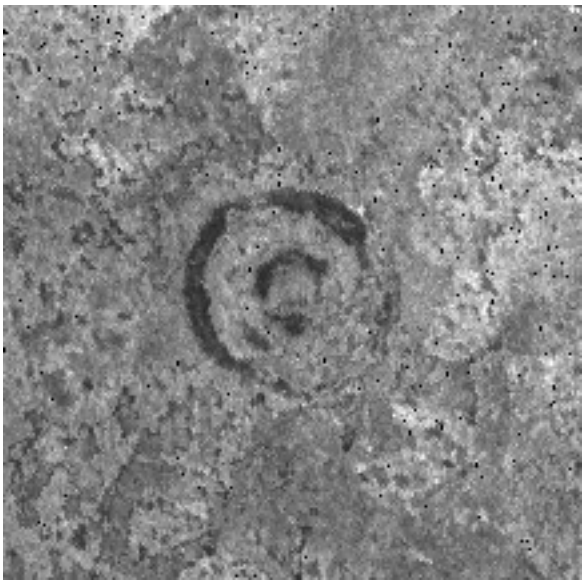

Figure 1. SIR-C L-band radar image of Habhab possible impact structure in southern Oman. Outer ring of radar-dark sand is 6 km in diameter, north is to top of page. SRL-2 Data Take 33.70