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Jasper Procurement, Trade, and Control in Orange County: Comments and Observations

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NO other issue in Orange County archaeology has been as intense and sustained as that surrounding the question of prehistoric jasper procurement/trade/control. The once-conventional wisdom that jasper recovered from Orange County sites was obtained in trade from desert regions to the east (McKinney 1967:27) went un-

uncontested (e.g., Hudson 1969:27) until Cottrell published her view that Orange County entrepreneurs procured the resource directly from the deserts (Cottrell and Del Chario 1984:59), thereby sparking a debate that included even source provenience as a point of contention (Koerper and Fife 1985).

The controversy continues, focusing on the following related hypotheses: (1) jasper found at Tomato Springs, Orange County (Fig. 1), was procured by local entrepreneurs engaged in forays into the Mojave Desert or beyond to acquire unmodified stone weighing as much as 11.67 kg. and (2) the Tomato Springs site (CA-Ora-244) was the primary or sole center for production and distribution of artifacts of jasper in coastal southern California (Cottrell 1985). Two critiques of Cottrell's jasper procurement/trade scenario (Koerper et al. 1987; Shackley 1987) posed numerous questions regarding lithic procurement, resource control, and tool manufacture. A recent commentary (Cottrell and Wagner 1990) neglected most of the concerns proffered by Koerper et al. (1987) and Shackley (1987) but rather focused on macroscopic and microscopic examination of Tomato Springs material to conclude that the Ora-244 jaspers are allochthonous to the Peninsular Ranges and therefore must have come from either the Mojave or Colorado desert. Here, we discuss those important issues not addressed by Cottrell and Wagner (1990). Next, petrological, petrographical, paleontological, and geochemical observations are offered to support a hypothesis of local jasper procurement. Included are data derived from scanning electron microscopy (SEM) and energy dispersive x-ray analysis (EDX) that indicate a high degree of correlation in morphology, crystallinity, and trace element chemistry between a sample of local float jasper and a debitage specimen from Ora-244.

PROCUREMENT

Answers to the following questions involving procurement are crucial to support or reject the hypotheses proposed by Cottrell (1985). First, how could direct jasper procurement have overridden efficient, long-distance regional exchange systems involving obsidian and other items (Ericson 1977, 1981)? Long-term, long distance, down-the-line trade into Orange County is well documented (Koerper et al. 1986; Ericson et al. 1989). Second, why would a large, 11.67-kg. chunk of jasper found near Tomato Springs (Cottrell 1985:845, Fig. 6) be transported perhaps as much as 290 km., or 180 miles, without modification, testing for quality, or further reduction? Third, more specifically, why would entrepreneurs not reduce the jasper into roughouts, blanks, or preforms, a standard practice of California Indians (Ball 1941)? The reduction of lithic materials prior to transport is well-documented (Ericson 1982, 1984; Singer 1987; Wilke and Schroth 1989; Gary and McLear-Gary 1990; Arnold 1992). Lastly, given the abundance of cherts within the catchment of Ora-244 and the larger coastal area, what would motivate local peoples to transport moderate quality lithics from the east to the coastal areas? Good quality cherts are locally available, particularly from stream and beach gravel beds, a fact emerging from the recent Newport Coast Archaeological Project investigations (R. Mason, personal communication 1992).

LOCAL RESOURCE CONTROL AND DISTRIBUTION

What independent evidence would support the belief that the jasper was controlled as a valuable resource by the Tomato Springs peoples (Cottrell 1985)? Generally, local control of resources among hunter-gatherers requires that the resource be sufficiently valuable to overcome the energy required to transport and distribute the resource (Morrow and Jefferies 1989). Given the regional availability of stone of at least equal quality for tool manufacture, control and distribution of long-distance procured jasper cannot be supported. Indeed, most hunter-gatherers cannot afford to transport large

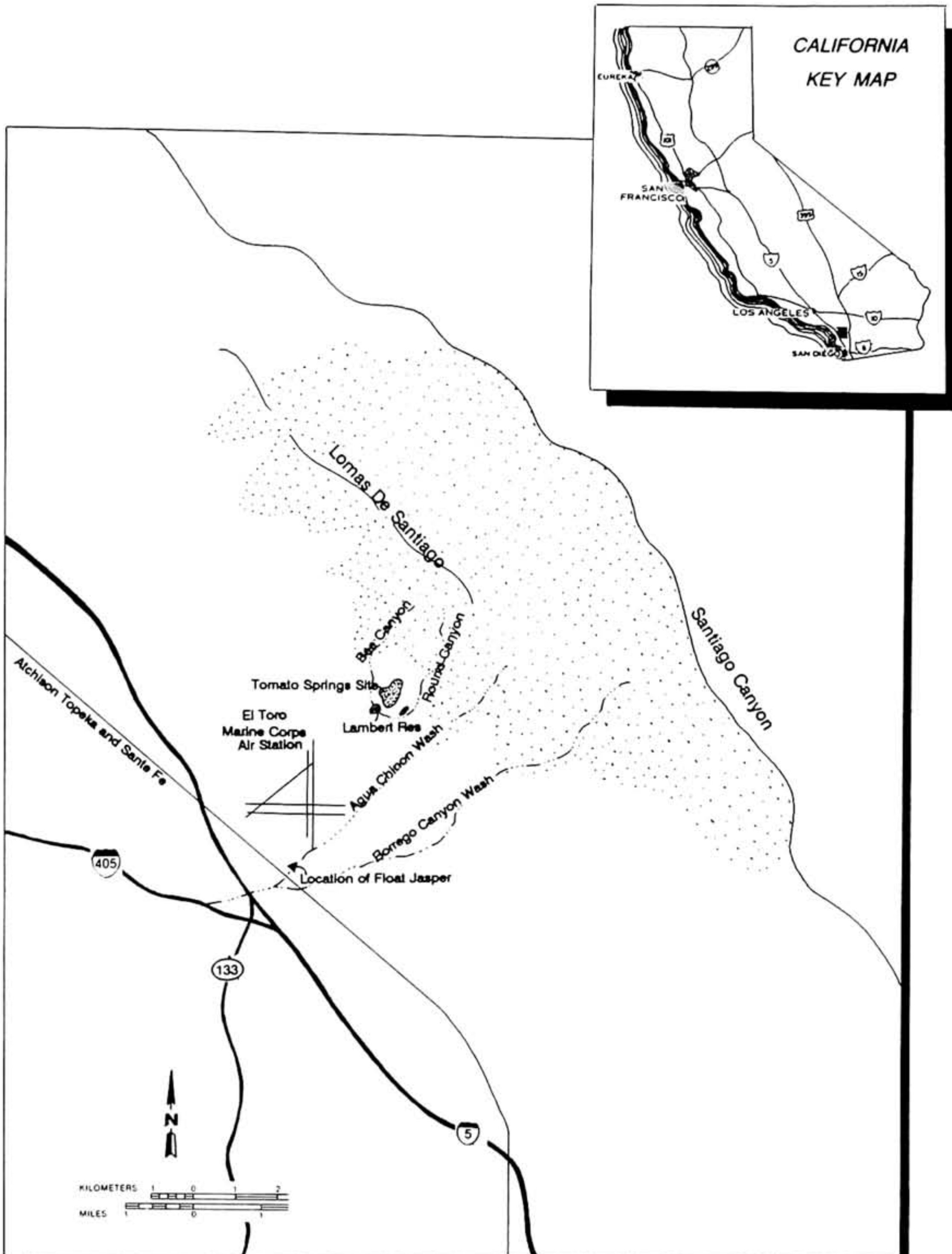

Fig. 1. Location of the Tomato Springs site, El Toro Marine Corps Air Station, and El Toro float jasper specimen.

quantities of material for market exchange. Further, Arnold (1985) has proposed that a significant archaeological indicator of craft specialization is evidence of some control over resources. The steatite craft specialists of Catalina Island controlled their quarries (Meighan and Johnson 1957:28), and Late Period craft specialists of Santa Cruz Island controlled the source of a local unique high-grade chert for microlith production (Arnold 1990). The procurement/trade scenario hypothesized by Cottrell (1985) should likewise have necessitated control at the source, but how could the Tomato Springs people have prevented others from exploiting their valued desert jasper at such a great distance?

TOOL MANUFACTURE

It was proposed that the Tomato Springs site was a biface production center (Cottrell 1985). If this were true, why were so few (only 15) jasper bifaces recovered relative to other tool types, such as 209 jasper scrapers and one jasper chopper? Why were no unfinished or broken biface preforms recovered (see Singer and Ericson 1977; Ericson and Purdy 1984)? Production failures would be expected for a variety of reasons, particularly end shock (lateral snap) and uncontrolled fracture (Arnold 1992:69, 97). Cottrell's support for a biface production center rests in part on the assertion that a 159:1 debitage to biface ratio indicates a biface production center. Why were no replicative experiments performed to determine what sort of debitage-to-tool ratio might be meaningful for the jasper?

Cottrell and Wagner also neglected to address a concern expressed in Koerper et al. (1987:625-626) regarding the comparison of ratios of jasper debitage to jasper tools at Orange County sites (Cottrell 1985:841). Cottrell's belief that Tomato Springs was the primary or sole production/distribution center for artifacts of desert jasper rests significantly on such comparisons with 65 sites. Yet, there is little data consistency among these sites (Koerper et al. 1987:625). Sample size and screen size vary among the sites, and there was no examination of any of the collections to verify the identification of the lithic materials or the artifact types. Further, Cottrell (1985:846, Table 3) believed that there was a tremendous difference in the proportion of jasper debitage to jasper tools at Tomato Springs (106:1) compared to other sites, evidence, she believed, that supported her hypothesis that Ora-244 was the major jasper production/distribution center in southern California. Her debitage-to-tool ratio of 106:1, is a miscalculation with an error factor of 10 (Koerper et al. 1987:625). Cottrell (1985:846, Table 3) reported 225 jasper tools (209 scrapers, 5 projectiles, 6 bifaces, 4 drills, and 1 chopper) against 2,384 pieces of jasper debitage at Ora-244. With the correction being 10.6:1, at least eight other Orange County sites listed by Cottrell (1985:842, 846) have higher debitage-to-tool ratios than Tomato Springs, which, following Cottrell's argument and criteria, casts serious doubt on her own hypothesis.

VISUAL ANALYSIS: MACROSCOPIC AND CONVENTIONAL MICROSCOPIC EXAMINATION

Most of the jasper found within prehistoric sites in Orange County is very distinctive at the macroscopic level. While some red jaspers with white veins do occur, most of the local material has a yellow to orange-brown matrix interlaced by distinctive clear chalcedonic veins, occasionally with drusy quartz crystals (Figs. 2 and 3). The majority of jasper flakes recovered at Ora-244 is of this latter variety, as is a float specimen found by one of us (DLF) within the immediate Tomato Springs catchment. We use the term "float" in its broader sense, to denote material separated from its outcrop by mass wasting or fluvial process. The Ora-244 specimen was chosen at random among a group of flakes, and it appeared typical with regard to color, texture and other attributes.

Microscopic inspection (using cross-polarized light) of thin sections prepared from the float piece from the Tomato Springs area (Sample 1), and from an Ora-244 debitage specimen (Sample 2) failed to reveal any significant differences between the two in terms of color, structure, or composition. We regarded this comparison of Samples 1 and 2 as a cursory, though a prerequisite, analysis before proceeding with analysis using a scanning electron microscope and an energy dispersive X-ray analyzer.

SEM AND EDX ANALYSIS

The basic objective of our SEM/EDX analysis was to conduct *in situ* chemical analysis of Samples 1 and 2 at high magnification. SEM allowed us to observe petrographic structures related to geologic events of the formation of the jasper samples and allowed us to identify targets for EDX analysis. EDX, as applied, is a qualitative rather than a quantitative method which analyzes X-rays that are byproducts of SEM in order to characterize the elemental chemistry of a sample target. The matrix (as opposed to the chalcedonic-filled veins) of Sample 1 was used as our standard of comparison for the observations of Table 1.

SEM and EDX procedures were accomplished with the cooperation of Sue Fisher, Director of the Electron Microscope Facility, University of California, Irvine. An Hitachi Model S-500 scanning electron microscope, set at 15 kv. (kilovolts), was coupled in tandem with a Tracor-Northern Model TN-200 X-ray analyzer equipped with a Be (beryllium) window.

SEM analysis indicated that the samples were nearly identical with respect to morphology of surfaces and pore spaces, crystallinity, and thickness of veins. EDX analysis indicated that the samples had nearly identical electrical resistance. Magnesium, silicon, phosphorus, sulfur, chlorine, potassium, calcium, titanium, manganese, iron, zinc, neodymium, and uranium were detected in the two samples. The presence of phosphorus, sulfur, neodymium and uranium in the samples is characteristic of the geochemistry of marine sediments. These elements precipitate from sea water and are deposited in marine sediments (Bowen 1979).

We observed a greater iron peak in the matrix of Sample 2 compared to Sample 1 (Table 1). It is well known that iron is quite variable in chert materials (Moore and Maynard 1929). The observed differences in our samples do not detract from assigning geologic provenance. Parenthetically, iron (in hematite) is probably the dominant colorant of the jaspers. The oxidation states of iron, which can be highly variable, account for the color variations (yellow, red, orange, orange-brown and yellow-brown) among jaspers. Manganese and its oxidation states are also factors in coloration.

The nearly identical concentrations of calcium and zinc in the matrices of Samples 1 and 2 provide very strong support for our hypothesis that the float jasper specimen from the Tomato Springs area and the Ora-244 debitage specimen are identical. The total trace element chemistry of the matrices of the two samples (Table 1) further supports the hypothesis that the jasper material for artifacts found at Ora-224 was procured locally. Three targets were also chosen from the Sample 1 veins for EDX analysis. The clear chalcedonic veins of Sample 1 were quite distinct from the matrix of Sample 1, most notably with higher amounts of magnesium, sulfur, manganese, neodymium, and uranium. There were considerably lower amounts of calcium in two of the vein targets, with iron, potassium, and chlorine being variable among the three vein samples. Further, EDX analysis of a vein of Sample 2 produced a spectrum that was compared against the spectrum of the standard vein of Sample 1, and the elemental chemistry of the two spectra was generally similar. These find-

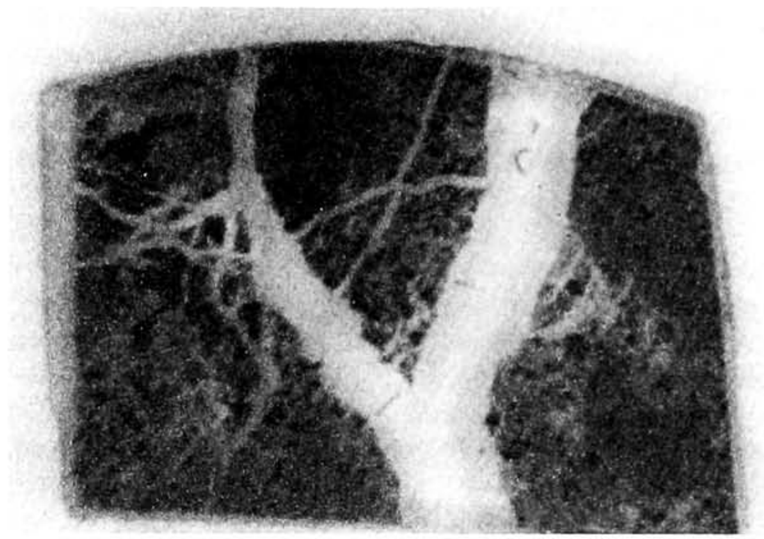

Fig. 2. Sample slide of float jasper from the Tomato Springs area (Sample 1) prepared for SEM analysis. Low magnification using SEM shows characteristic chalcedonic veins in jasper matrix.

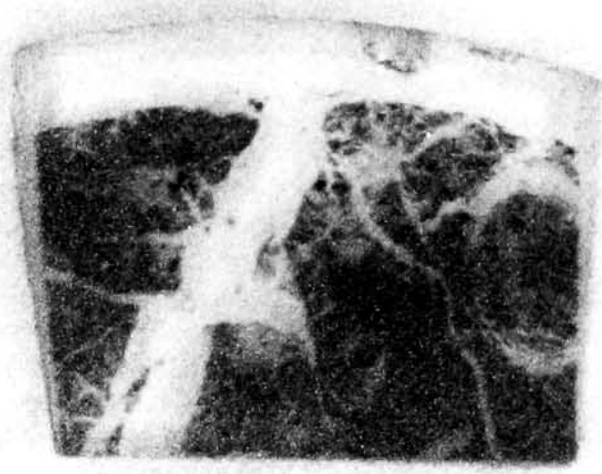

Fig. 3. Sample slide of CA-Ora-244 jasper debitage (Sample 2) prepared for SEM analysis. Low magnification using SEM shows characteristic chalcedonic veins in jasper matrix.

ings support the argument against that posed by Cottrell (1985) and Cottrell and Wagner (1990) which presumes long-distance procurement of jasper found at the Tomato Springs site.

MICRO-PALYNOLOGICAL/ PALEONTOLOGICAL ANALYSIS

The discovery of additional local float jasper casts further doubt on the validity of the long-distance procurement hypothesis. A fist-sized cobble of jasper weighing 881 g. was recently found 5 km. south southwest of Tomato Springs and just south of the El Toro Marine Air Station, Orange County (Fig. 1). It was discovered 1.5 m. below the ground surface during grading activities on land devoid of any prehistoric midden deposit. The specimen gave no evidence of modification by prehistoric man and

Table 1
GEOCHEMICAL COMPARISON OF CA-Ora-244 DEBITAGE (SAMPLE 2) WITH STANDARD (SAMPLE 1) MATRIX

Elements	Ora-244 Debitage-relationship to standard[a]
Magnesium	similar
Silicon	similar
Phosphorus	significantly lower
Sulfur	similar
Chlorine	similar
Potassium	slightly higher
Calcium	nearly identical
Titanium	higher
Manganese	similar
Iron	significantly higher
Zinc	nearly identical
Neodymium	higher
Uranium	similar

[a] Standard is Sample 1, float jasper from Tomato Springs area.

was probably fluvially transported from the Santa Ana Mountains via one of two washes: Agua Chinon Canyon or Borrego Canyon (P. Jertberg, personal communication 1989). The source of a vast majority of the cobbles in the fluvial terraces and alluvium of the coastal Tustin Plain may be attributed to the middle Eocene to Oligocene Sespe Formation which forms the ridge for the short local drainages of Agua Chinon Canyon and Borrego Canyon. The Sespe Formation represents a fluvial-deltaic deposit formed by a large river system which had its origins in southeastern California, south central Arizona, and/or northern Sonora (Belyea and Minch 1989; Minch et al. 1976; Minch 1979). It is widely held that the source of the Sespe clasts is somewhere in the Colorado Desert, Arizona, and/or northern Sonora. As such, the jaspers in the Sespe and younger rock formations are most probably from Mesozoic rock outcrops in desert sources beyond the Peninsular Ranges and were transported via fluvial systems which traversed the Peninsular Ranges prior to their uplift.

Based on macroscopic inspection, the characteristics of the El Toro specimen appear nearly identical to the unmodified float specimen from Tomato Springs (Koerper et al. 1987:624). The El Toro chert is also nearly identical to the majority of jasper artifacts from the Tomato Springs site, as well as artifacts found in many other Orange County prehistoric middens.

For a stratigraphic study undertaken by paleontologists Satish K. Srivastava and Edward Marks (1991), three thin sections were prepared from the El Toro specimen (Samples 3A, 3B, and 3C) to be compared against Sample 1 (Tomato Springs float) and Sample 2 (Ora-244 debitage). Our principal interest was focused on the further microscopic examination and photo-micrography that might allow us to make relevant statements about the jaspers recovered locally. Analysis of the five thin sections (Samples 1, 2, 3A, 3B, 3C) indicated great similarity between the specimens (Srivastava and Marks 1991) (Table 2). All five samples are characterized by the presence of amorphous, black coaly organic matter and the presence of foraminifers. Foraminifers, or forams, are chiefly marine rhizopods, indicating that the jasper samples formed as marine deposits. The thermally altered coaly organic matter is from a terrestrial source.

Sample 3A received special processing for pollen and foram analysis (Srivastava and Marks 1991:2-3). For this El Toro float jasper specimen, Srivastava and Marks (1991:3) reported that Late Mesozoic fern megaspores were present with the jasper. Such fern megaspores do not occur later than the Cretaceous (Srivastava, personal communication 1992). Later, a post-depositional thermal event oxidized the organic matter.

Table 2
THIN-SECTION ANALYSIS: SAMPLE COMPARISONS OF TWO LOCAL FLOAT JASPER SPECIMENS WITH JASPER FROM CA-Ora-244

Sample 1, float jasper, Tomato Springs area	Mesozoic Large, amorphous black coaly organic matter (TAI=3.5-4.0). Coiled foraminifera-like structures. Late Tertiary Very little evidence. Unidentified bright yellow organic fragments, probably angiosperm pollen (TAI=1.75).
Sample 2, jasper debitage, CA-Ora-244	Mesozoic Large, amorphous black coaly organic matter (TAI-3.5=4.0). Foraminifera-like structures with more amorphous organic matter or minerals on chamber margins than Sample 1.
Sample 3A, float jasper, El Toro area	Mesozoic Large, amorphous black coaly organic matter (TAI=3.5-4.0). Three specimens of coiled forams, one specimen of biserial foram.
Sample 3B, float jasper, El Toro area	Mesozoic Large amorphous black coaly organic matter (TAI=3.5-4.0). Some foraminiferal specimens with mineral coating over test chamber walls.
Sample 3C, float jasper, El Toro area	Mesozoic Large amorphous black coaly organic matter (TAI=3.5-4.0). Some foraminifera.

SUMMARY AND CONCLUSIONS

Continuous long-distance transport of large, unmodified chunks of jasper, untested for quality or further reduced, is contrary to our understanding of the economic behavior of native peoples. Entrepreneurs engaged in market exchange, travelling long distances to procure a resource of moderate value, is also contrary to our understanding of native peoples.

Rather, we support a simple, practical interpretation of the Tomato Springs data with regard to jasper supply. The jasper used at Tomato Springs was of local origin. Our primary evidence supporting this hypothesis is the natural occurrence of jasper within the catchment of the site. We have tested our hypothesis using multiple, independent tests. We find nearly identical chemical and physical properties shared by local naturally occurring jasper and the jasper debitage recovered from the Tomato Springs site (Ora-244). We conclude that the Tomato Springs jasper artifacts are of locally derived materials.

We do not support arguments which elevate Tomato Springs as a major prehistoric jasper manufacturing and distribution center. Rather we suggest that Tomato Springs people played a minor to moderate role in regional exchange which might not have included local jasper. Our primary evidence is the low debitage-to-tool ratio (10.6:1), the low frequency of debitage and preforms, and the absence of rejected preforms at Tomato Springs. Furthermore, we suggest that most of the jasper was manufactured for on-site use, an argument supported by the blank-to-scraper ratio. We propose a model in which jasper artifacts from other Orange County sites come from local sources. There is much evidence emerging, especially from the recent Newport Coast Archaeological Project investigation (R. Mason, personal communication 1992), to indicate that jasper is both locally available and a feature of Early, Middle and Late assemblages and that Orange County prehistoric quarries were largely stream and beach gravel beds.

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