

Data Repository Table DR-1. Ar release spectra for volcanic glasses of the Stonyford volcanic complex.

Laser (W)	$^{40}\text{Ar}/^{39}\text{Ar}$	$^{37}\text{Ar}/^{39}\text{Ar}$	$^{36}\text{Ar}/^{39}\text{Ar}$	$^{40}\text{Ar}^*/^{39}\text{Ar}_K$	% $^{40}\text{Ar}^*$	Age (Ma)	$\pm 2s$ (Ma)
G-2/3524-01		J= 0.01950 \pm 0.00004					
1.4	5.4505	5.9027	0.0044	4.6056	84.2	155.2	4.6
1.8	5.1465	5.8310	0.0033	4.6299	89.6	156.0	4.1
2.2	5.3367	5.7358	0.0040	4.6148	86.1	155.5	2.0
2.5	5.1368	5.8798	0.0028	4.7716	92.5	160.5	2.0
2.6	4.9393	5.7819	0.0017	4.8953	98.7	164.5	1.6
2.7	4.9145	5.8171	0.0018	4.8262	97.8	162.3	3.5
2.8	4.9158	5.8244	0.0017	4.8758	98.8	163.9	1.0
2.9	4.9315	5.7907	0.0017	4.8810	98.6	164.0	1.1
3.0	4.9872	5.8463	0.0019	4.8764	97.4	163.9	2.5
3.2	4.9254	5.7464	0.0016	4.9005	99.1	164.7	1.4
3.4	4.9692	5.8184	0.0017	4.9313	98.9	165.7	1.8
3.6	4.9866	5.7856	0.0019	4.8833	97.6	164.1	1.7
3.9	4.9923	5.7711	0.0019	4.8952	97.7	164.5	1.6
4.3	5.0119	5.7722	0.0020	4.8723	96.8	163.8	4.1
Plateau Age (Ma)						164.3	1.2
G-2/3524-03		J= 0.01950 \pm 0.00004					
0.5	5.8165	6.0492	0.0057	4.6141	79.0	155.4	2.0
0.7	5.0914	5.8338	0.0027	4.7625	93.2	160.2	2.1
0.9	5.0515	5.8597	0.0018	4.9777	98.2	167.1	3.6
1.1	4.9347	5.8352	0.0018	4.8596	98.1	163.4	1.8
1.2	4.9441	5.8824	0.0017	4.9117	99.0	165.0	3.1
1.3	4.9320	5.8431	0.0017	4.8792	98.5	164.0	1.8
1.4	4.9759	5.5631	0.0017	4.9222	98.6	165.4	1.7
1.5	5.0186	5.8939	0.0019	4.9072	97.4	164.9	1.0
1.6	4.9765	5.9813	0.0019	4.8764	97.6	163.9	1.8
1.7	5.3531	6.0566	-0.0128	9.6262	179.1	310.4	112.8
1.8	6.2775	5.5654	0.0103	3.6629	58.1	124.5	40.8
1.9	5.7823	5.7991	0.0106	3.0966	53.3	105.8	50.9
2.0	5.3008	6.0194	0.0008	5.5443	104.2	185.2	198.4
Plateau Age (Ma)						164.6	1.4

G-2/3524-04

J= 0.01950 ±0.00004

1.9	8.1989	5.8326	0.0175	3.4911	42.4	118.8	6.9
2.2	6.6895	4.9392	0.0174	1.9232	28.7	66.4	26.2
3.0	5.0310	5.8458	0.0024	4.7939	94.9	161.2	1.3
3.2	5.1426	5.8311	0.0029	4.7334	91.7	159.3	5.0
3.5	5.9477	5.8031	0.0068	4.3954	73.6	148.4	7.7
3.8	5.5090	5.7228	0.0037	4.8654	88.0	163.5	2.7
4.1	5.1469	5.9894	0.0046	4.2581	82.4	143.9	3.3
4.4	5.0473	5.8604	0.0021	4.8819	96.3	164.1	4.9
4.7	5.0708	5.8570	0.0025	4.8000	94.3	161.4	2.8
5.0	5.1480	5.9151	0.0045	4.2916	83.0	145.0	3.6
5.3	5.0510	5.8031	0.0053	3.9279	77.5	133.2	8.6
5.6	5.1025	5.8927	0.0048	4.1401	80.8	140.1	2.9
5.9	5.1409	5.9067	0.0038	4.4774	86.8	151.0	4.9
6.2	5.0528	5.8676	0.0023	4.8442	95.5	162.9	1.6
6.5	5.0354	5.8699	0.0020	4.8933	96.8	164.4	0.9
0.0	5.2367	5.8662	0.0027	4.9013	93.2	164.7	0.9

Plateau Age (Ma)**164.3** 1.4**G-2/4445-01**

J= 0.02320 ±0.00004

0.4	14.9898	6.4896	0.0420	3.0740	20.4	124.3	17.9
0.5	7.0663	5.9758	0.0135	3.5433	49.9	142.5	13.2
0.6	5.8320	5.8604	0.0087	3.7203	63.5	149.4	18.3
0.7	4.9880	5.9442	0.0062	3.6141	72.2	145.3	10.5
0.9	4.5307	5.9899	0.0033	4.0361	88.7	161.5	3.9
1.1	4.6507	5.9222	0.0034	4.1178	88.2	164.6	3.3
1.2	4.6642	5.8001	0.0034	4.1010	87.6	164.0	2.9
1.3	4.5726	5.8537	0.0031	4.1131	89.6	164.4	2.1
1.4	4.5978	5.8065	0.0033	4.0744	88.3	162.9	8.2
1.5	4.5179	5.8320	0.0032	4.0398	89.1	161.6	7.6
1.7	4.9304	6.0073	0.0045	4.0540	81.9	162.2	4.1
2.0	4.6137	6.0569	0.0033	4.1163	88.9	164.6	2.9

Plateau Age (Ma)**163.8** 2.4

G-4/4446-01		J= 0.02320 ±0.00004					
0.7	6.1796	4.9144	0.0087	3.9823	64.2	159.4	5.0
0.9	4.8111	4.7686	0.0036	4.1068	85.1	164.2	11.4
1.1	4.6384	4.7346	0.0028	4.1661	89.5	166.4	8.6
1.2	4.6640	4.6821	0.0026	4.2567	91.0	169.9	9.6
1.3	4.5743	4.7266	0.0031	4.0330	87.9	161.4	7.8
1.4	4.4977	4.5846	0.0025	4.1136	91.2	164.4	10.7
1.5	4.3730	4.6235	0.0024	4.0171	91.6	160.8	10.0
1.6	4.6900	4.7208	0.0034	4.0564	86.2	162.3	13.7
1.7	4.2593	4.8112	0.0018	4.1147	96.3	164.5	1.1
1.8	4.2702	4.7580	0.0019	4.0849	95.4	163.3	1.2
2.0	4.4373	4.8954	0.0023	4.1324	92.8	165.2	1.3
2.2	4.3579	4.8693	0.0022	4.0752	93.2	163.0	1.8
Plateau Age (Ma)						164.1	1.4

G-4/4446-02		J= 0.02320 ±0.00004					
0.5	8.8120	4.5843	0.0214	2.8435	32.2	115.3	13.4
0.7	4.7322	4.4952	0.0051	3.5664	75.1	143.4	4.5
0.9	4.6485	4.5305	0.0032	4.0662	87.2	162.6	2.5
1.1	4.5236	4.6022	0.0027	4.0813	89.9	163.2	1.8
1.2	4.4912	4.6356	0.0028	4.0265	89.4	161.1	4.8
1.3	4.3555	4.7008	0.0021	4.1115	94.1	164.4	1.0
1.4	4.9700	4.7932	0.0042	4.1000	82.2	163.9	2.9
1.6	5.7182	5.0282	0.0069	4.0568	70.7	162.3	3.9
1.8	5.2128	4.9837	0.0050	4.1109	78.6	164.3	1.9
2.0	4.7982	5.0509	0.0041	3.9678	82.4	158.9	1.6
Plateau Age (Ma)						163.9	1.6

G-8/4447-01		J= 0.02320 ±0.00004					
0.4	24.9170	4.7251	0.0804	1.5144	6.1	62.3	84.6
0.5	9.5320	7.5391	0.0234	3.1886	33.3	128.8	45.6
0.6	6.0813	7.9462	0.0082	4.2920	70.2	171.2	25.7
0.7	5.4556	7.7418	0.0061	4.2502	77.5	169.7	22.5
0.8	5.0828	8.0700	0.0052	4.1769	81.7	166.9	10.0
0.9	4.8225	8.0146	0.0045	4.1264	85.1	164.9	10.0
1.0	4.8080	8.1830	0.0048	4.0208	83.2	160.9	8.7
1.1	4.9352	8.4140	0.0050	4.1038	82.7	164.1	8.6
1.2	4.5395	8.2200	0.0037	4.0964	89.7	163.8	5.0
1.3	4.4243	8.0973	0.0032	4.1144	92.5	164.5	2.4
1.4	4.5303	8.1366	0.0037	4.0734	89.4	162.9	8.4
1.5	4.4056	8.1577	0.0030	4.1460	93.6	165.7	5.5
1.6	4.3596	8.0227	0.0029	4.1409	94.5	165.5	4.9
1.7	4.3607	8.0886	0.0028	4.1719	95.2	166.7	3.1
2.0	4.2702	8.1002	0.0027	4.1034	95.6	164.1	1.6
Plateau Age (Ma)						164.6	2.2

G-8/4447-02

$J= 0.02320 \pm 0.00004$

0.5	10.0276	6.0168	0.0273	2.4216	24.1	98.6	20.8
0.7	4.7019	7.6446	0.0051	3.8004	80.4	152.4	7.3
0.9	4.4458	8.1867	0.0045	3.7552	84.0	150.7	8.1
1.1	4.2323	8.1239	0.0029	3.9944	93.9	159.9	3.4
1.2	4.2298	8.2379	0.0026	4.0954	96.3	163.8	2.3
1.3	4.1699	7.8929	0.0022	4.1365	98.7	165.3	1.6
1.4	4.2747	7.8427	0.0022	4.2298	98.4	168.9	5.5
1.6	4.2262	8.1032	0.0025	4.1080	96.7	164.2	1.9
1.8	4.2093	8.0233	0.0025	4.0860	96.6	163.4	2.4
2.0	4.2553	8.2549	0.0027	4.1049	95.9	164.1	1.6
2.2	4.2010	8.2295	0.0024	4.1433	98.1	165.6	1.7

Plateau Age (Ma)**164.7** 1.6**G-5/4448-01**

$J= 0.02320 \pm 0.00004$

0.5	9.0467	4.8369	0.0178	4.1577	45.8	166.1	3.5
0.7	4.7931	4.8670	0.0038	4.0606	84.4	162.4	2.8
0.9	4.5715	4.8002	0.0028	4.1045	89.5	164.1	2.1
1.1	4.4804	4.7716	0.0025	4.1041	91.3	164.1	2.4
1.2	4.4203	4.7868	0.0023	4.1013	92.5	164.0	1.9
1.3	4.7403	4.7958	0.0035	4.0734	85.7	162.9	2.4
1.4	4.7329	4.6454	0.0031	4.1662	87.8	166.5	5.3
1.5	4.5361	4.8257	0.0028	4.0969	90.0	163.8	5.5
2.0	4.7146	4.8864	0.0036	4.0396	85.4	161.6	4.2
2.2	4.7927	4.8555	0.0037	4.0857	85.0	163.4	2.0

Plateau Age (Ma)**163.7** 1.8**G-5/4448-01**

$J= 0.02320 \pm 0.00004$

0.4	30.9391	3.1457	0.0912	4.2446	13.7	169.4	26.1
0.5	17.7776	3.3412	0.0468	4.2220	23.7	168.6	15.7
0.6	20.6942	4.3307	0.0574	4.0573	19.5	162.3	27.4
0.7	16.3524	4.4359	0.0435	3.8323	23.4	153.7	18.0
0.8	13.9827	4.4730	0.0350	3.9962	28.5	160.0	11.2
0.9	11.1687	4.5153	0.0251	4.1117	36.7	164.4	10.7
1.0	12.9163	4.7041	0.0306	4.2524	32.8	169.7	8.0
1.1	12.1102	4.4312	0.0282	4.1128	33.9	164.4	7.2
1.2	10.4991	4.3873	0.0230	4.0534	38.5	162.1	7.8
1.3	8.5395	4.6100	0.0165	4.0325	47.1	161.3	4.9
1.4	9.7409	4.7710	0.0201	4.1727	42.7	166.7	4.5
1.5	11.3687	5.0148	0.0255	4.2135	36.9	168.3	8.8
1.6	11.9626	5.0010	0.0285	3.9399	32.8	157.8	11.4
1.7	12.0371	5.0567	0.0280	4.1569	34.4	166.1	9.4

Plateau Age (Ma)**164.4** 2.3

Notes:

All errors reported are 2s

J-values are based on 28.02 Ma for Fish Canyon sanidine; uncertainty does not include age error

Power refers to laser output in Watts. Note that different samples were run with different laser focus.

Isotope ratios are corrected for blanks, mass discrimination, and radioactive decay

Ages are based on nucleogenic corrections reported by Renne et al. (1998) and decay constants of Steiger and Jager (1977)

Age errors do not include systematic contributions from decay constants or J value

Errors reported for plateau ages include analytical error in J determination

DR-2: Technical notes on biostratigraphic calibrations and correlations

Range discordancies , range diachronism, and other sources of uncertainty

Biostratigraphic zonations, like absolute time scales, are inherently works-in-progress. Neither the zonation of Baumgartner et al. (1995a) nor of Pessagno et al. (1987, 1993) produces perfectly concordant results in all Cordilleran sections (Murcheý and Baumgartner, 1995; and herein). Range discordancies, which are overlapping ranges that are dissonant with ranges in a formal zonation, result from unrecognized range diachronism or reworking. In the Cordillera, significant environmentally-controlled diachronism at the genus level is well-documented: e.g., *Praeparvicingula*, *Parvicingula*, *Pantanellium* (Pessagno and Blome, 1984), and *Mirifusus* (Murcheý and Baumgartner, 1995). Therefore, we took some care to note range discordancies arising from application of the Tethyan UA Zonation of Baumgartner et al. (1995a) to the sections discussed. In addition, we have summarized some of the assumptions and uncertainties associated with previous calibrations based on the zonation of Pessagno et al. (1993) as they apply to specific sections. Kiessling's (1999) recalibrations of Subzones 2 α to 4 α of Pessagno et al. (1987, 1993), which incorporate data from a well-constrained Kimmeridgian and Tithonian section, brought the Late Jurassic calibrations of the two major zonation schemes into much closer alignment, but did not directly address the problems of reconciling the calibrations of Superzone 1 and Zone 2 (Subzones 2 δ , 2 γ , and 2 β) of Pessagno et al. (1987, 1993) with the UA Zonation.

Josephine ophiolite, Western Klamath Mountains, northern California and Oregon:

UAZ calibrations: Baumgartner et al. (1995a) used the radiolarian faunas documented by Pessagno et al. (1993) to calibrate the sedimentary sections intercalated with and overlying basalt of the Josephine ophiolite. At the Turner-Albright Mine in Oregon, where sedimentary rocks are interbedded with basalt, they assigned two intervals on strike with one another to UAZ 3-4. An argument can be made that the interval can be further constrained to UA Zone 4 based on the presence of *Unuma typicus* (UAZ 3-4), *Levileugeo* spp. (equivalent to *Leugeo hexacubicus* sensu Baumgartner et al., 1995, UAZ 4-8), and a species with affinity to *Cyrtocapsa* (?) *kisoensis* (UAZ 3-4). UA Zone 4 is calibrated as late Bajocian. The samples also contain common to abundant *Praecaneta decora* (which may fall within Baumgartner et al.'s (1995b) definition of

Parvicingula(?) spinata, UAZ 3-10); *P. decora* first occurs in the Bathonian of the Blue Mountains of Oregon above a late Bajocian to early Bathonian unconformity (Pessagno and Whalen, 1982).

In the Smith River section, 46m of tuffaceous pelagic strata overly basalt of the Josephine ophiolite (fig. 7). The horizon 4.1 meters above the base of the basalt is no older than UAZ 3 (early to middle Bajocian) because it contains *Acanthocircus suboblongus* (UAZ 3-11); it is constrained as no younger than UAZ 6 or 7 based on overlying assemblages. *Praecaneta decora* (see above), is present in the horizon and in an underlying sample. In figure 7, we correlated the base of the section with the approximate boundary between the Bajocian and Bathonian of the Blue Mountains of Oregon.

The interval between 13 and 46 meters is assigned a range of UAZ 6-6/7. The maximum range (UAZ 6, middle Bathonian) of the interval is based on the presence of *Emiluvia hopsoni* (UAZ 6-15) in many samples from 13 meters to the top of the volcanopelagic section, and on the presence of *Spongocapsula palmerae* (UAZ 6-13) at the ~21m horizon. Several other taxa in the interval range no lower than UAZ 5 (latest Bajocian to early Bathonian): *Ristola procera*, *Mirifusus guadalupensis*, *Eucyrtidiellum ptyctum* (sensu Baumgartner et al., 1995), and *Bernoullius cristatus*. The minimum age of the interval is constrained by several taxa in the upper part of the volcanopelagic section which have their final occurrences in UAZ 7: *Tetraditryma praeplena*, *Bernoullius r. delnortensis*, *Linaresia beniderkoulensis*, and *Linaresia* spp. *Xiphostylus* spp. (UAZ 1-6) are common throughout the interval. However, we choose not to rely completely on this genus to constrain the upper limit of the section because its upper range in the eastern Pacific is questionable (discussion in Baumgartner et al., 1995, p. 1041). It is present in the Bathonian but not in the Callovian of the Blue Mountains (Pessagno et al., 1989); it is present in a single sample of the Stanley Mountain section (Hull, 1997) along with taxa calibrated as UAZ 7 (late Bathonian to early Callovian); and it is present and highly discordant in the uppermost sample of the Smith River section (see below). The UAZ ranges of the pantanellids *Pachyoncus* (*Pantanellium* sp. L: UAZ 2-4) and *Trillus* (UAZ 1-5) are discordant; however, in the Blue Mountains of Oregon, *Pachyoncus* occurs in both the Bajocian and upper Bathonian (Pessagno and Blome, 1980). In summary, the interval between 13 and 46 meters is

illustrated in Fig. 7 as having a possible range of UAZ 6-6/7, and is calibrated as no older than middle Bathonian and no younger than late Bathonian or early Callovian.

The radiolarian faunas in the upper half of the Smith River section are much lower in diversity than those in the underlying pelagic section (Pessagno et al., 1993). They are dominated by taxa whose ranges are not yet well-established elsewhere nor used in the UA Zonation of Baumgartner et al. (1995b). The ranges that Baumgartner et al. (1995) assigned to this interval (Fig. 7) are based on very few taxa, including *Mirifusus d. diana*e (UAZ 7-12), *Mirifusus guadalupensis* (UAZ 5-11), and *Podobursa spinosa* (UAZ 8-12), so the results are imprecise. The most tightly constrained part of the interval (UAZ 8-10) still has a possible range from Callovian to Kimmeridgian. The reappearance of the genus *Xiphostylus* sp. (UAZ 1-6)(species unidentified), in a single sample about 9.5m below the top of the Smith River section, is a highly discordant occurrence which is not integrated into Figure 7. Either the upper UAZ range of the genus needs to be revised (discussion in Baumgartner et al., 1995a, p. 1041) or it was reworked from the underlying volcanopelagic section, the last reported occurrence being 51.7m below. Pessagno et al. (1993, p. 111) reported that the “ upper 15.2m of the syntectonic flysch succession contain common, small rip up clasts of light gray pelagic limestone.”

Age calibrations of Pessagno et al. (1993): Pessagno et al. (1993) described the radiolarians in the sedimentary rocks overlying the Josephine ophiolite in great detail, but they did not use them to calibrate the sections. They considered existing calibrations for Jurassic radiolarian zonations of Europe and Japan to be erroneous or to reflect systematic range diachronism of radiolarians or ammonites (Pessagno et al. (1993, p. 103-107).

Pessagno et al. (1993a, after Pessagno and Blome, 1990), used a radiometric date of ~162 Ma on a plagiogranite locality about 13 km from the Smith River section as a proxy for the age of the basalt basement at the Smith River section in California and the Turner-Albright Mine section in Oregon. This method provided a rough estimate for the maximum ages of the sedimentary sections, but the cumulative uncertainties built into the analysis were and remain very large. The actual zircon $^{206}\text{Pb}/^{238}\text{U}$ and $^{207}\text{Pb}/^{235}\text{U}$ dates are 162 Ma, with no uncertainty quoted (revised from 157 ± 2 Ma; Saleeby, 1987) and the $^{207}\text{Pb}/^{206}\text{Pb}$ date is 163 ± 5 Ma (Harper et al. 1994). Palfy et al. (2000, Appendix 1: Item 46) assigned the sample a crystallization age of $162 +7/-2$ Ma, based on apparent lead loss and the absence of a duplicate concordant fraction.

Pessagno et al. (1993) considered 161 Ma to be the boundary between the Oxfordian and Callovian. Accordingly, they calibrated basalt in both sections as late Callovian in age and arbitrarily placed the boundary between the Callovian and Oxfordian within the lower 13 meters of the pelagic section of the Smith River sequence. In this way, Pessagno et al. (1993) calibrated the reference intervals for their new Zones 1H (Turner-Albright Mine section) and 1I (lower 13 m of the Smith River section). In the more recent time scale of Palfy et al. (2000), the Bathonian ranges from 166.0 +3.8/-5.6 Ma to 160.4 +1.1/-0.5 Ma. Using this time scale and a crystallization age of 162 +7/-2 Ma, one plagiogranite site within the Josephine ophiolite crystallized sometime between the Bajocian and early Callovian. At best, the reanalyzed data provide only a very indirect and crude constraint on the maximum ages of the sedimentary sections but, interestingly, the results are compatible with the UAZ calibrations of *in situ* radiolarian assemblages.

The upper half (56 meters) of the Smith River section is a transitional interval between pelagic and hemipelagic strata below and thick bedded graywacke sandstone and conglomerate facies above. The total thickness of the massive flysch sequence is more than 500m (Harper, 1994; Pinto-Auso and Harper, 1985). Pessagno et al. (1993, p. 116) suggested an interval of metamorphism following deposition of the pelagic interval and preceding deposition of the transitional interval. A few kilometers from the measured section, the flysch sequence contains the middle Oxfordian to late Kimmeridgian bivalve *Buchia concentrica* (Pessagno et al., 1993 per Diller, 1907, Harper, 1983). Therefore, the upper part of the Smith River section is no younger than *B. concentrica* but could be older, in part or whole. Pessagno et al. (1993) made the interpretation that the upper part of the Smith River section lies entirely within the middle Oxfordian. They made a lithologic correlation between the upper part of the Smith River section and the lower part of the type Galice Formation, which contains a middle Oxfordian megafossil assemblage of *B. concentrica* as well as the Oxfordian ammonite *Dichotomosphinctes* (Imlay, 1961, 1980). Pessagno and Blome (1990) did not identify any species-level radiolarians in the type Galice, although they reported the presence of two long-ranging genera, *Mirifusus* and *Praeparvicingula* (revised from *Parvicingula* by Pessagno et al., 1993). At the genus level, neither is sufficient for inter-basin correlation. The type Galice lies in a separate fault-bounded subterranean about 60 km to the north. The formation depositionally overlies a succession of calc-alkaline volcanic and volcanoclastic rocks, the Rogue Formation, rather than tuffaceous pelagic

strata. Pessagno and Hull (2002, text-figure 9) illustrated a “probable hiatus and unconformity” between the base of the type Galice and the underlying Rogue Formation. Pessagno et al.’s (1993) correlation assumes the synchronous onset of syntectonic flysch deposition in the two separate fault-bounded subterranean basins. The middle Oxfordian calibration of the upper part of the Smith River section is a reasonable approximation but it implies a precision that does not exist given the nature of clastic systems, the interbasin differences in pre-flysch stratigraphy, and the inferred hiatuses or unconformities. Still, the calibration is compatible with the poorly constrained Callovian to Kimmeridgian calibration obtained from the UA Zonation of Baumgartner (1995a, see above) for part of the section. More recently, Pessagno and Hull (2002) described two well-dated Oxfordian samples from the East Indies. Neither sample contains any of the markers used in the zonation of Pessagno et al. (1993) but a few of the 50 species-level taxa in the East Indian samples occur in the upper part of the Smith River section: *Paronaella cleopatraensis*, *Praeparvicingula hurdygurdyensis*, and *Praeparvicingula deadhorsensis*. At present, their full ranges are not well-calibrated; *Paronaella deadhorsensis* also occurs in the Tithonian of Antarctica, for example (Kiessling, 1999).

Additional notes on correlations: Stonyford interval A3 correlates particularly well with the Smith River section between 19 m and 22 m based on the presence in each of *M. fragilis*, *M. guadalupensis* (transitional from *M. fragilis*), *Eucyrtidiellum u. pustulatum*, *Hisocapsa convexa* gp., *Acanthocircus suboblongus*, *Tetraditryma corralitosensis corralitosensis*, *Xiphostylus gasquentensis* gp., *Praecaneta decora*, *Ristola procera*, *Levilleugeo*, and *Paronaella bandyi* (Pessagno et al., 1993a and figure 6, this study). Stonyford intervals B3 and C and the upper part of the Smith River sequence both contain *M. guadalupensis*, *M. d. diana* (*M. mediodilatatus* in Pessagno et al., 1993a) and abundant *Praeparvicingula* spp. The Diversion Dam fauna, in which Pessagno (1977) noted *M. d. baileyi*, may be the same age or may be younger than the upper part of the Smith River sequence which did not include *M. d. baileyi* among the few specimens of the genus (1 or 2 each in two samples) reported from the latter (Pessagno et al., 1993a: Text-Figure 18).

Stanley Mountain ophiolite, southern Coast Ranges, California

Hull and Pessagno (1995) compared the calibrations of the Stanley Mountain section using the Tethyan UA Zonation of Baumgartner et al. (1995) and the North American Zonation of

Pessagno et al. (1993). Based on the Tethyan UA Zonation, the lower part of the Stanley Mountain composite section is Middle Jurassic in age and the upper part is Late Jurassic; based on the zonation of Pessagno et al. (1993), the section is entirely Late Jurassic in age. The latter calibration is a key element in the interpretation of Hopson et al. (2000) that a major hiatus occurs at the base of the sedimentary sequence. In the following discussion and in figure 7, our UAZ calibrations do not precisely correspond with the generalized ranges given by Hull and Pessagno (1995), in part, because we incorporated some additional sample data.

The lower 28 meters of the Stanley Mountain composite section represents a substantial accumulation of tuffaceous pelagic sediment. *Eucyrtidiellum ptyctum* (UAZ 5-11) in strata 3.8 m above the base of the section (Pessagno et al. , 1984) limits the maximum possible range of the section to UAZ 5, or no older than late Bajocian or early Bathonian. *Mirifusus diana diana* (UAZ 7-12; senior synonym of *M. mediodilatatus*) occurs 21 m above the base of the Stanley Mountain section (Pessagno et al., 1984). The only faunal assemblage in the lower 28 meters that has been well-described lies far above the basalt basement at the 27.1 meter horizon (Hull, 1995, 1997, Hull and Pessagno, 1995). It is no younger than UAZ 7 as constrained by the ranges of *Palinandromeda depressa* (UAZ 3-7), *Ristola altissima major* (UAZ 5-7), *Stichocapsa decora* (UAZ 4-7), and *Kilinora spiralis* (UAZ 6-7),. In Figure 7, we have illustrated the presence of range discordancies in the sample by showing its range as “UAZ 6/7-6/7”: the ranges of *Unuma echinatus* (UAZ 1-6), *Xiphostylus* (UAZ 1-6), and *Tricolocapsa plicarum* ssp. A (UAZ 4-5, *sensu lato* UAZ 3-8) are discordant and older than the ranges of co-occurring species *Mirifusus d. diana* (UAZ 7-12), *Sethocapsa dorysphaeroides* (UAZ 7-22), and *Williriedellum carpathicum* (UAZ 7-11). UAZ 6 is calibrated as Bathonian; UAZ 7 as latest Bathonian to early Callovian. In summary, the lower part of the Stanley Mountain composite section is no younger than early Callovian as calibrated by the UA Zonation, and the lowest strata could be significantly older.

Pessagno et al. (1993) used the first occurrences of *Mirifusus d. diana* (21 m above basement) and *E. ptyctum* (3.8 m above basement) to redefine their Subzone 2 γ , for which the lower part of the Stanley Mountain section is a principal reference section. They calibrated the evolutionary first occurrence of *Mirifusus d. diana* as middle Oxfordian based on the species' presence in a single sample of the Smith River section, 60.2 m above the basalt basement and about 15 m above a possible hiatus preceding flysch deposition (Pessagno et al., 1993).

However, a single-sample range of a long-ranging taxon indicates local range truncation. No compelling evidence indicates that the evolutionary first occurrence of *M. diana diana* is better calibrated by the Smith River section than in the UA Zonation, where it is calibrated as latest Bathonian or early Callovian. Pessagno et al. (1993) did not independently calibrate the first occurrence of *Eucyrtidiellum ptyctum* (*sensu* Pessagno et al., 1993), which is not present in the Smith River section; they estimated the event to be middle Oxfordian as well. In the UA Zonation, this species' (*sensu* Baumgartner et al., 1995) first occurrence is calibrated as latest Bajocian or early Bathonian. (UAZ 5). In conclusion, Pessagno et al. (1993) did not make a strong case that the base of the Stanley Mountain sedimentary section is middle Oxfordian

The calibrations of the upper part of the Stanley Mountain section are less disparate and, therefore, less controversial. Hull (1997) assigned the interval between 28 and 62 meters above the basalt basement to Subzone 2 β of Pessagno et al. (1993), which is not independently calibrated in a North American reference section. In the zonation of Baumgartner et al. (1995), a sample from the 45.6 meter horizon has a possible range from UAZ 7 (late Bathonian to early Callovian) to UAZ 8 (middle Callovian to early Oxfordian) based on the limiting ranges of *Mirifusus d. diana* (UAZ 7-12), *Crucella theokaftensis* (UAZ 7-11), *Sethocapsa dorysphaeroides* (UAZ 7-22), *Williriedellum carpathicum* (UAZ 7-11), *Mirifusus fragilis* s.l. (UAZ 3-8), and *Tricolocapsa plicarum* s.l. (UAZ 3-8). Another sample collected 59.8 meters above basalt (Hull, 1997, p. 201) is assigned a possible range from UAZ 7 (late Bathonian to early Callovian) to UAZ 10 (late Oxfordian to early Kimmeridgian) based on the constraining ranges of *Williriedellum carpathicum* (UAZ 7-11), *Paronaella bandyi* (UAZ 3-10), and *Angulobracchia purisimaensis* (UAZ 3-10).

Hull (1997) assigned the interval between 62 and about 80 meters to Zone 3 of Pessagno et al. (1993). Zone 3 is middle Oxfordian to late Kimmeridgian according to the recalibrations of Kiessling (1999). In the UA Zonation of Baumgartner et al. (1995), samples 62m and 75m above basalt basement are no older than UAZ 9 (middle to late Oxfordian) based on the presence of *Mirifusus diana baileyi* (UAZ 9-11) and no younger than UAZ 10 (late Oxfordian to early Kimmeridgian) based on the UAZ ranges of radiolarians in overlying strata.

Hull (1997) assigned the interval between 80 and 104 meters to Subzone 4 β of Pessagno et al. (1993). The Subzone 4 β interval in the Stanley Mountain section is herein assigned a range of

UAZ 10-10 (late Oxfordian to early Kimmeridgian) based on the constraining ranges of *Acanthocircus trizonalis dicranacanthos* (UAZ 10-17; 80 m), *Acaeniotyle umbilicata* (UAZ 10-22; 90.5m), *Tetraditryma corralitosensis corralitosensis* (UAZ 3-10; 85.5m), *Homoeoparonaella* (?) *giganthea* (UAZ 8-10; 90.5m), *Homoeoparonaella elegans* (UAZ 4-10; 90.5m), *Paronaella bandyi* (UAZ 3-10; 90.5m), *Paronaella mulleri* (UAZ 6-10), *Transhsuum maxwelli* gp. (UAZ 3-10; 90.5m), *Tritrabs casmaliaensis* (UAZ 4-10; 99.1m), and *Angulobracchia purisamaensis* (UAZ 3-10, 104m). The interval is secondarily constrained as no younger than UAZ 11 (late Kimmeridgian to early Tithonian) by the presence of the following taxa: *Emiluvia orea orea*, *Napora pyramidalis*, *Mirifusus diana baileyi*, *Acanthocircus trizonalis trizonalis*, *Triactoma blakei*, *Tritrabs exotica*, and *Perispyridium ordinarium* gp.. Several taxa with discordant ranges are also present in this interval: *Gorgansium* (UAZ 3-8), *Hexastylus*(?) *tetradactylus* (UAZ 1-4), *Sethocapsa*(?) *zweili* (UAZ 14-19), *Triactoma luciae* (UAZ 13-21), and *Acanthocircus carinatus* (UAZ 18-22). Pessagno et al. (1993) calibrated the base of Zone 4, Subzone 4 β , as late Tithonian based on the apparent timing of four selected biostratigraphic events in subsiding basin sequences in Mexico. Only one of the four events is calibrated in the UA Zonation: the first occurrence of *Acanthocircus t. dicranacanthos* during UA Zone 10 (late Oxfordian to early Kimmeridgian). More recently, Kiessling (1999) illustrated that the other three formal marker events occurred no later than late Kimmeridgian in an ammonite-dated Antarctic section: the first occurrences of *Vallupus hopsoni*, *Hsuum mclaughlini*, and *Parvicingula colemani*. Kiessling (1999) recalibrated the range of Subzone 4 β as late Kimmeridgian to early Tithonian.

The boundary between the tuffaceous pelagic section and the lowermost Great Valley Supergroup lies about 130 meters above basalt basement. *Tritrabs casmaliaensis* (UAZ 4-10) ranges at least as high as 125.2 meters above the base of the Stanley Mountain section. The uppermost part of the tuffaceous pelagic section and the lowermost part of the clastic Great Valley Supergroup are constrained as no younger than UAZ 12 (early to early late Tithonian) based on the occurrences of the following taxa reported by Hull (1997, p. 202): *Podobursa spinellifera* (125.2m), *Ristola altissima* (141.9m, 146.4m), and *Loopus primitivus* (145m). Hull (1997) assigned this interval to Subzone 4 α of Pessagno et al. (1993), which Kiessling (1999) recalibrated as early to late Tithonian based on ranges in Antarctica.

Point Sal ophiolite, southern Coast Ranges

The UAZ ranges for the condensed, 21 m pelagic section at Point Sal are based on published taxonomic lists (Baumgartner, 1995, Appendix: p. 1105-1106; Pessagno, 1977; Pessagno et al., 1984) (figure 7). *Eucyrtidiellum ptyctum* (UAZ 5-11) occurs just above basalt basement and constrains the maximum possible age of the section as no older than late Bajocian or early Bathonian. *Mirifusus d. diana* (*M. mediodilatatus*) (UAZ 7-12) occurs at 4.5m and further constrains the maximum age of the lower part of the section as no older than late Bathonian or early Callovian. A sample 11.5 meters above the basalt basement is herein assigned a range of UAZ 8-8 (middle Callovian to early Oxfordian) based on the limiting ranges of *Mirifusus fragilis* (UAZ 3-8), *Parahsuum stanleyensis* (UAZ 3-8), *Monotrabs plenoides* gp. (UAZ 5-8), *Napora lospensis* (UAZ 8-13), *Triactoma cornuta* (UAZ 8-10), *Podobursa spinosa* (UAZ 8-13), and *Archaeodictyomitra apiarium* (UAZ 8-22). The range of *Deviatus diamphidius hipposidericus* (UAZ 9-13) is slightly discordant. This sample is a reference for Subzone 2 α (undifferentiated) of Pessagno et al. (1993), which was initially calibrated as late Kimmeridgian based, in large part, on correlation with a sample from the base of the Great Valley sequence near Paskenta in Northern California. The basis for the correlation, the first occurrence of *Parvicingula* in both sections, was arguable owing to a major unconformity below the Great Valley sample. Subzone 2 α was subsequently recalibrated by Kiessling (1999) as ranging from the early Oxfordian to early middle Oxfordian. An overlying sample at the 13.4 m horizon is a primary reference for the base of Subzone 3 β of Pessagno et al. (1993) which is defined by the first occurrence of *M. d. baileyi*. The sample is no older than UAZ 8 (middle Callovian to early Oxfordian) based on the limiting ranges of *Napora lospensis* (UAZ 8-13), *Emiluvia pessagnoii multipora* (UAZ 8-14), *Podobursa spinosa* (UAZ 8-13), and *Archaeodictyomitra apiarium* (UAZ 8-22). It is no younger than UAZ 9 (middle to late Oxfordian) based on the limiting range of *Ristola procera* (UAZ 5-9). However, in Figure 7 we illustrate its range as UAZ 8/9-8/9 because the ranges of *Turanta flexa* (holotype in this sample; UAZ 6-8), and *M. d. baileyi* (holotype in this sample; UAZ 9-11).are discordant. About 16m above the base, the radiolarians are assigned to UAZ 9-10 based on the constraining ranges of *M. d. baileyi* (UAZ 9-11), *Paronaella broennimanni* (UAZ 4-10), and *Tritrabs casmaeliaensis* (UAZ 4-10). This sample is a reference for the top of Subzone 3 β . Pessagno et al. (1993) calibrated Subzone 3 β as Tithonian; Kiessling (1999) recalibrated Subzone 3 β as middle Oxfordian to late Kimmeridgian. The top of the section (about 19m above

basement) is assigned a range of UAZ 9-11 (Oxfordian to early late Tithonian) based on the ranges of *M. d. baileyi* (UAZ 9-11) and *Eucyrtidiellum ptyctum* (UAZ 5-11).