



WORLD BREWING CONGRESS

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#ElevateBeer



Bourbon Barrel aged Beer Flavor Analysis

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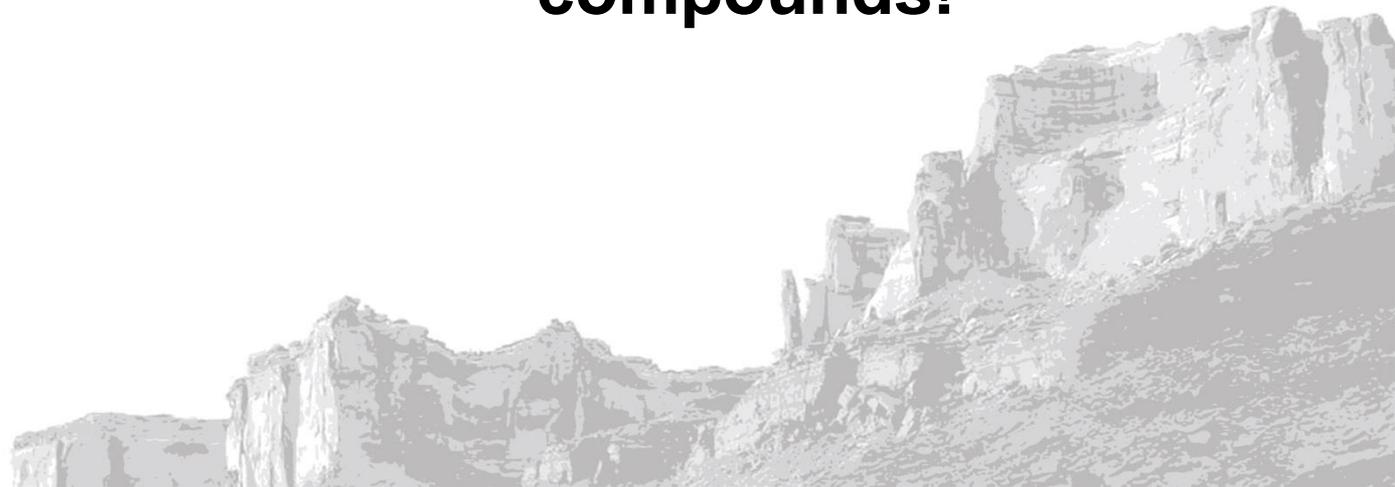
Flavor Characteristics of Bourbon Barrel aged Beers

Raw Oak Compound Flavor Contributions

- Spice
- Wood Sugars
- Coconut
- Raw Wood/Pencil Shavings

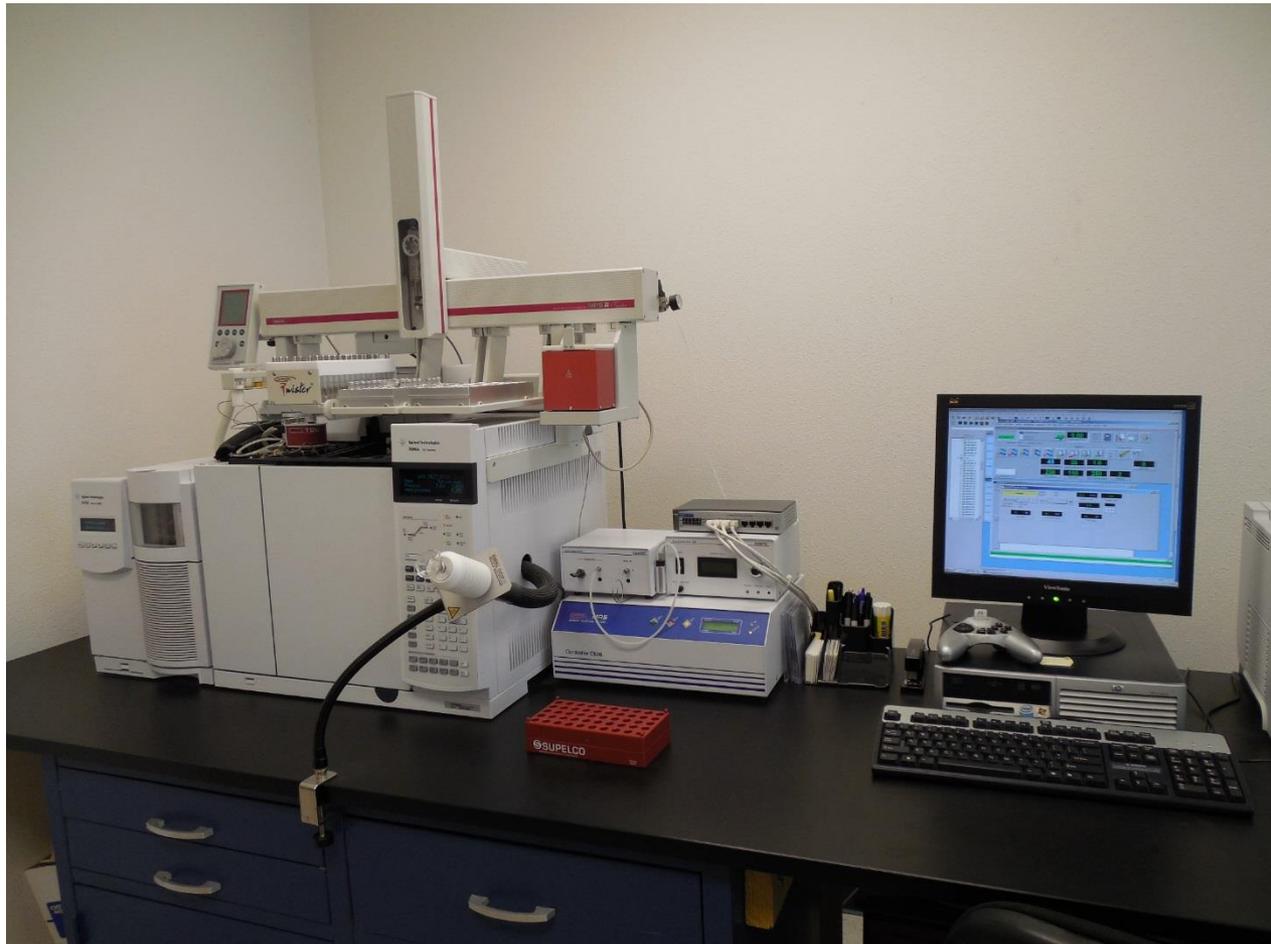
Toasted/Charred Compound Flavors

- Furans: Caramels, Acrid pungency, toasted notes
- Smoke aromas
- **Vanilla: 3 different types of vanilla compounds!**





Analytical Method for Oak Analysis: GC/MS





Flavor Markers Analyzed in this Method

- Raw Oak Compounds:
 - cis-Lactone
 - trans-Lactone
- Furans:
 - 5-Hydroxymethyl Furfural
 - 5-Methyl Furfural
 - Furfural
 - Furfuryl Alcohol
- Smoke and Spice Compounds:
 - Guaiacol
 - Eugenol
 - trans-Iso Eugenol
 - cis-Iso Eugenol
- Other Pyrolysis Products
 - Vanillin



What Did We Analyze?

A strong ale using a single recipe aged in three types of bourbon barrels presented a unique opportunity to monitor for flavor and chemical analysis. The Goal was to analyze each barrel type quarterly.

The Data set included:

- Set 1: never used, virgin bourbon barrels freshly charred, racked to barrel in Nov 2012
- Set 2: Bourbon barrels previously housing 10 year old bourbon, racked to barrel in Nov 2012*
- Set 3: Bourbon barrels previously housing a high gravity dark beer, racked to barrel in Aug 2012*

* Both of these sets of barrels contained the same 10 year old Kentucky bourbon prior to beer fill.



Raw Data, but What Does it Mean?

	Flavor Threshold (ppb)	Brand New Bourbon Barrels				1st use after Bourbon Barrels				2nd use after Bourbon Barrels			
		3 month concentration		7 month concentration		3 month concentration		7 month concentration		7 month concentration		10 month concentration	
		ppb	OAV*	ppb	OAV*	ppb	OAV*	ppb	OAV*	ppb	OAV*	ppb	OAV*
5-Methyl Furfural	1000	110	0.1	90	0.1	40	0.0	50	0.1	50	0.1	50	0.1
5-Hydroxymethyl Furfural	1000	1400	1.4	2000	2.0	1100	1.1	2600	2.6	1800	1.8	2900	2.9
Furfural	3000	620	0.2	490	0.2	290	0.1	560	0.2	680	0.2	650	0.2
Vanillin	50	740	14.8	380	7.6	380	7.6	300	6.0	570	11.4	270	5.4
Guaiacol	10	20	2.0	20	2.0	9	0.9	10	1.0	10	1.0	10	1.0
trans-Lactone	20	10	0.5	20	1.0	10	0.5	20	1.0	10	0.5	20	1.0
cis-Lactone	20	70	3.5	150	7.5	130	6.5	210	10.5	90	4.5	120	6.0
Furfuryl Alcohol	8000	6100	0.8	7100	0.9	5200	0.7	6300	0.8	6000	0.8	6900	0.9
Eugenol	10	10	1.0	20	2.0	5	0.5	8	0.8	4	0.4	5	0.5
trans-Iso Eugenol	10	5	0.5	40	4.0	3	0.3	20	2.0	2	0.2	20	2.0
cis-Iso Eugenol	10	6	0.6	8	0.8	4	0.4	5	0.5	4	0.4	4	0.4

* Odor Activity Values: number of times past the minimum flavor threshold.



Odor Activity Values Provide Meaning to the Data

Odor Activity Value (OAV) =
Analysis Value/Flavor Threshold!

This can be graphed to provide meaningful data.





Flavor Thresholds

Compound	Flavor Imparted	Flavor Threshold
5-Methyl Furfural	Toast/Butterscotch/Caramel; Acrid in very high concentrations	1000
5-Hydroxymethyl Furfural	Toast/Butterscotch/Butter/Caramel	1000
Furfural	Bread/Toast/Butterscotch/Caramel; Acrid in very high concentrations	3000
Furfuryl Alcohol	Bready/Burnt; Acrid in very high concentrations	8000
Vanillin	Natural Vanilla	50
trans-Lactone	Fresh Oak/Coconut	20
cis-Lactone	Fresh Oak/Coconut (stronger isomer?)	20
<u>Eugenol</u>	Spice/Clove	10
<u>Guaiacol</u>	Smoke	10
trans-Iso Eugenol	Spice/Clove/Carnation	10
cis-Iso Eugenol	Spice/Clove	10





Compounds with Odor Activity Values above 1

cis-Lactone

Vanillin

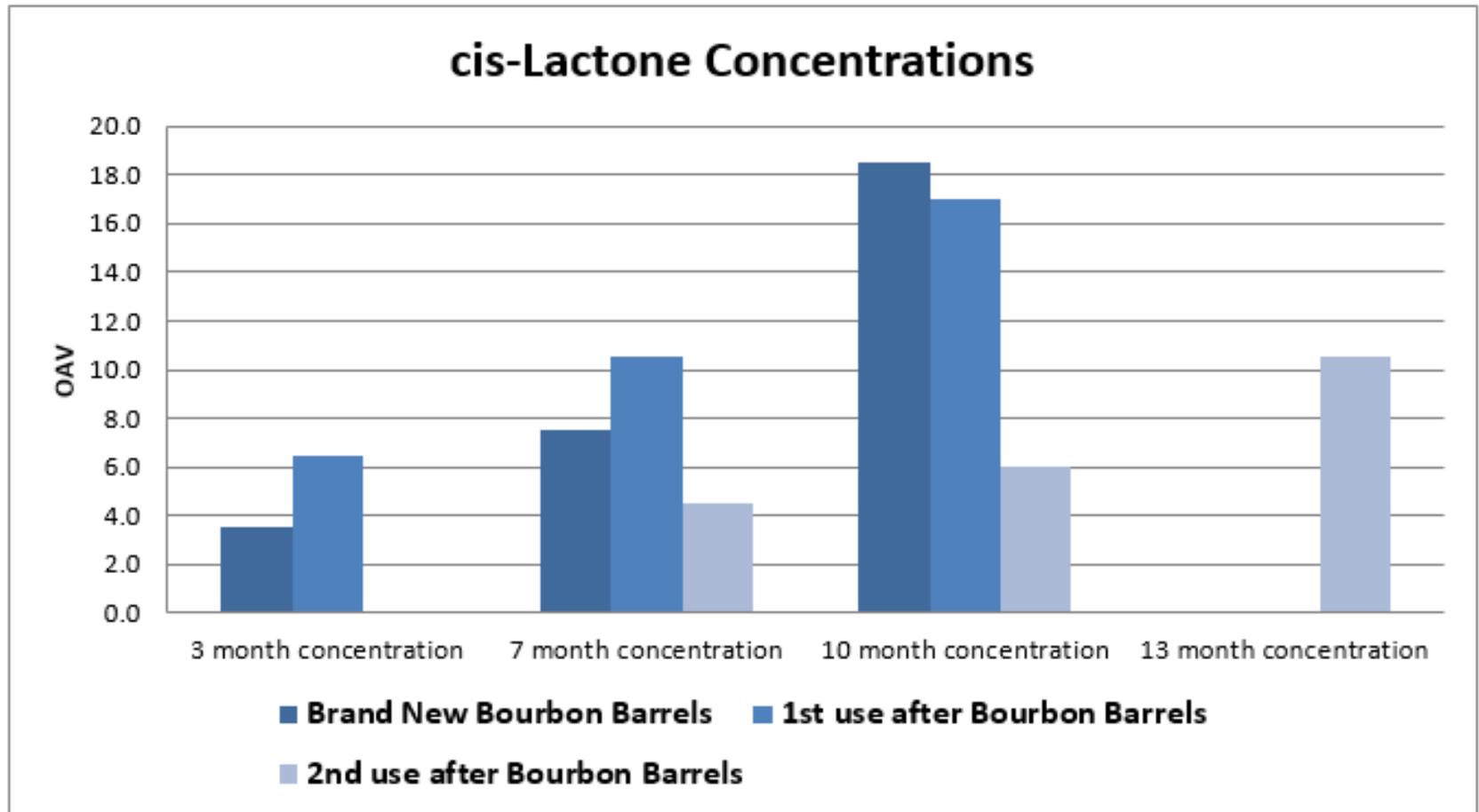
5-Hydroxymethyl Furfural (found in some dried fruits, especially prunes...used by some distiller as an analytical marker for extraction)

To a lesser extent Guaiacol, Eugenol, and trans-Iso Eugenol



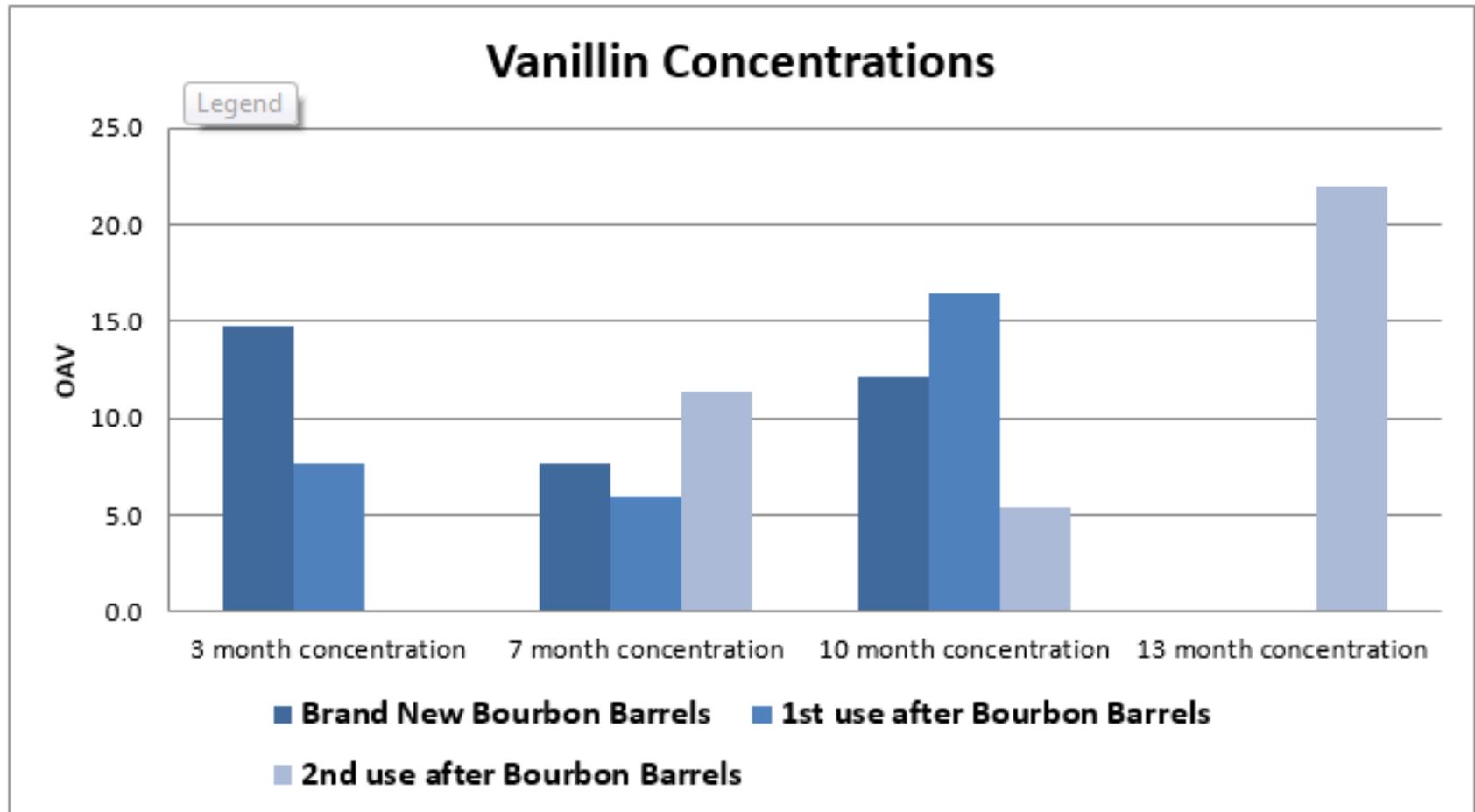


cis-Oak Lactone





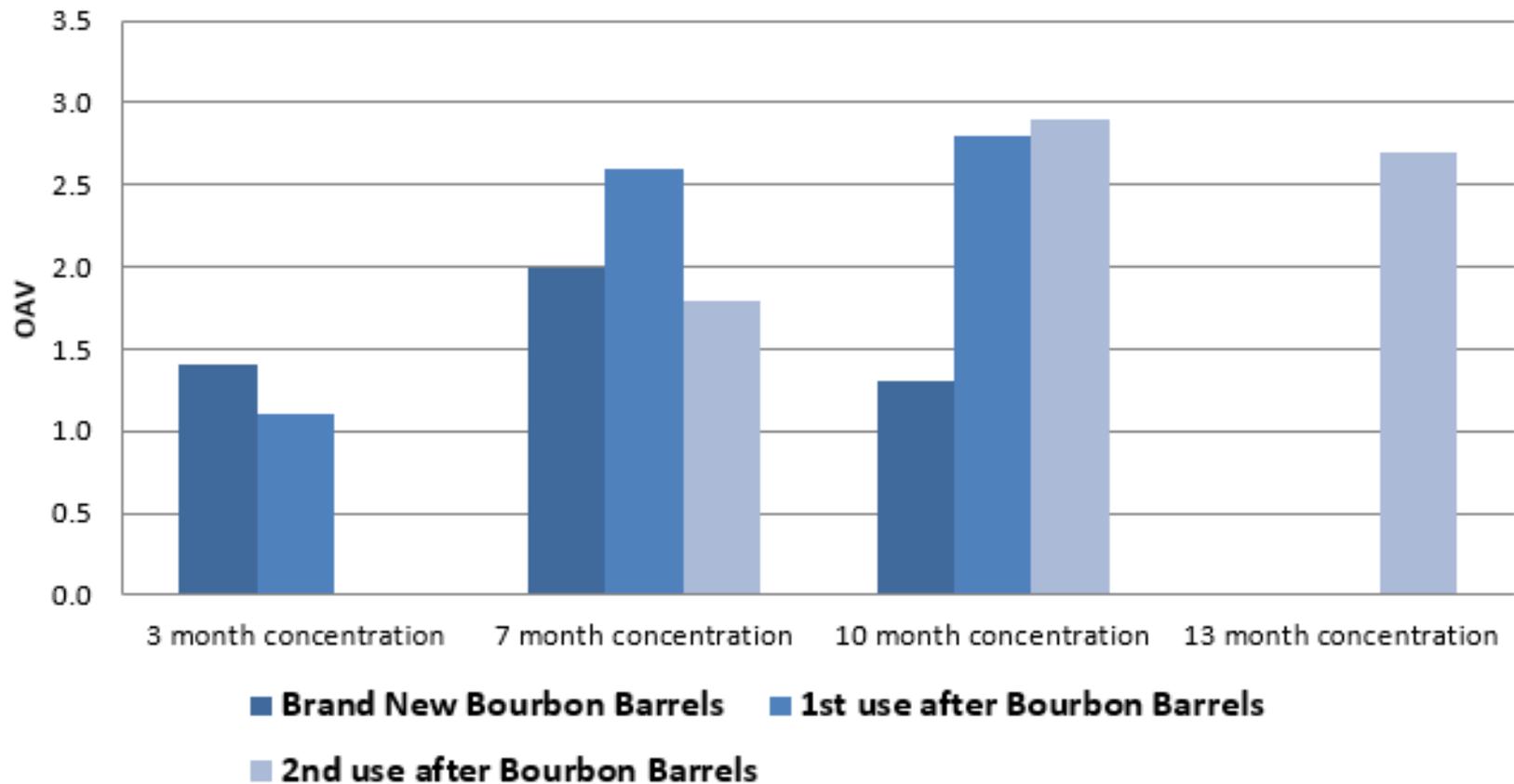
Vanillin





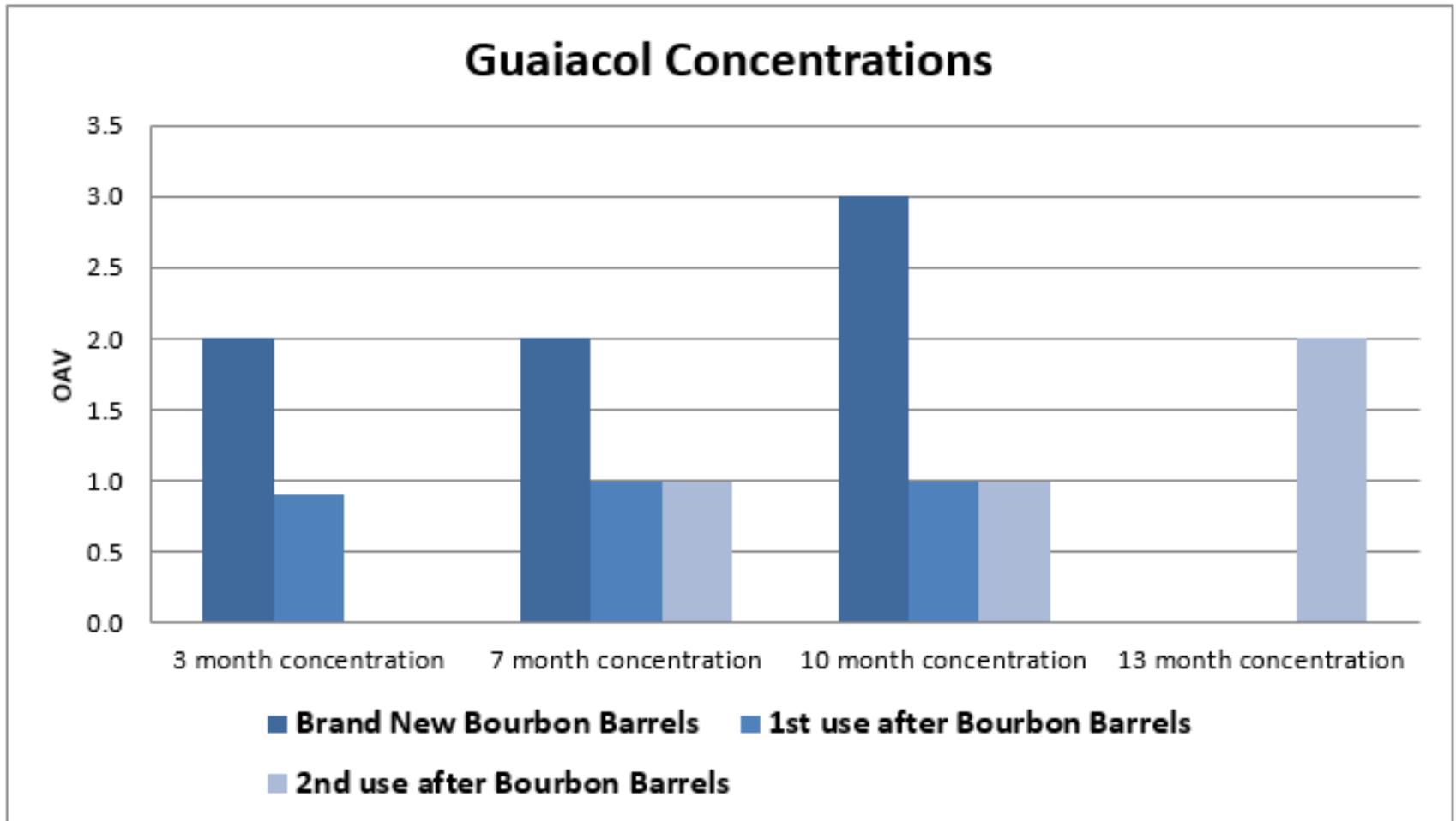
5-Hydroxy Methyl Furfural

5-Hydroxymethyl Furfural Concentrations



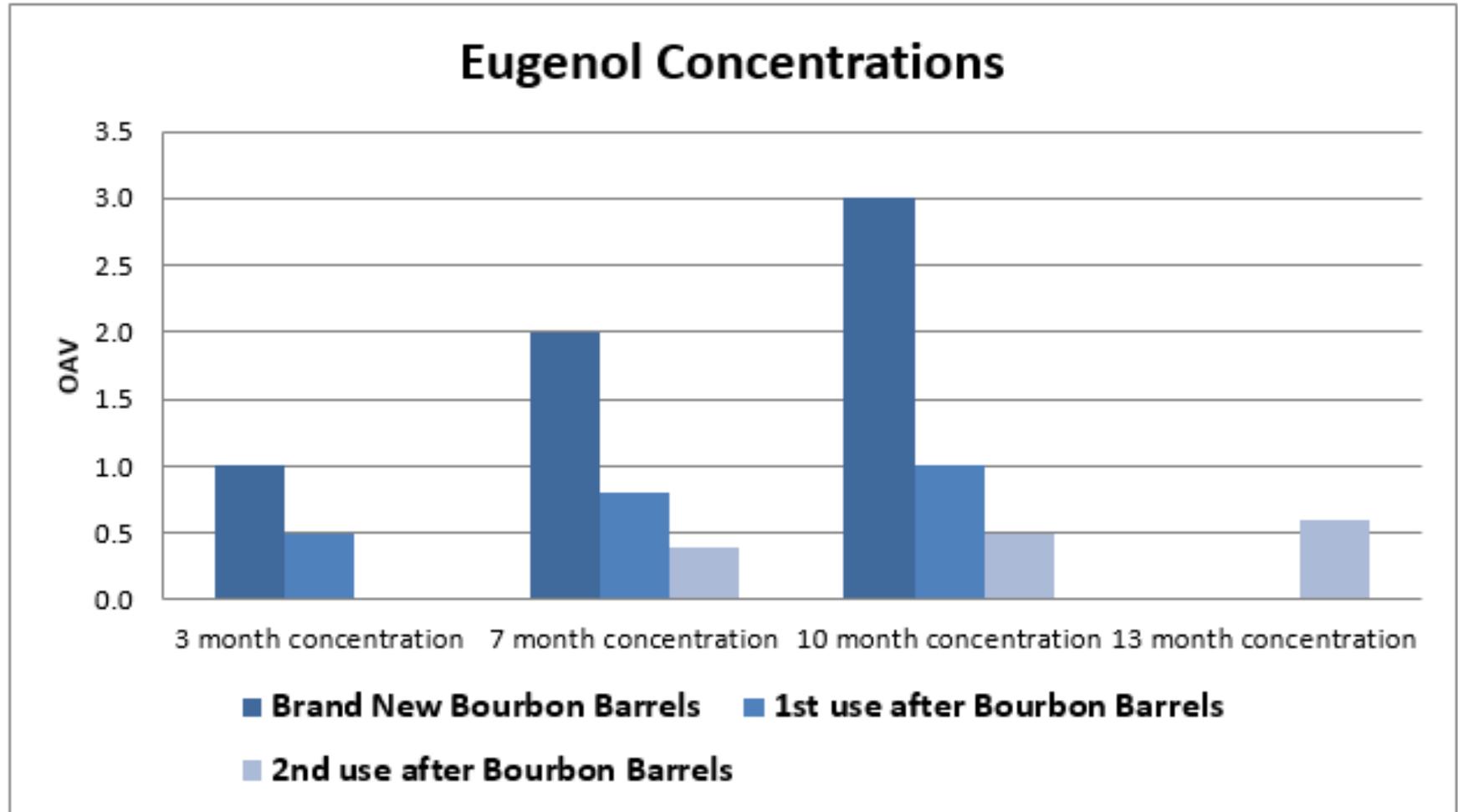


Guaiacol





Eugenol



**SO WHAT DOES ALL OF THIS
MEAN?**

**IT'S A GOOD CORRELATION
FOR WHAT MANY OF US
ALREADY KNOW!**



**SLOW OXIDATION IS ADDITIVE
TO BARREL AGED BEER
FLAVORS?
EVACUATE BARRELS WITH
CO₂ PRIOR TO FILLING?**



Other Testing

Oak Chip Beer testing.

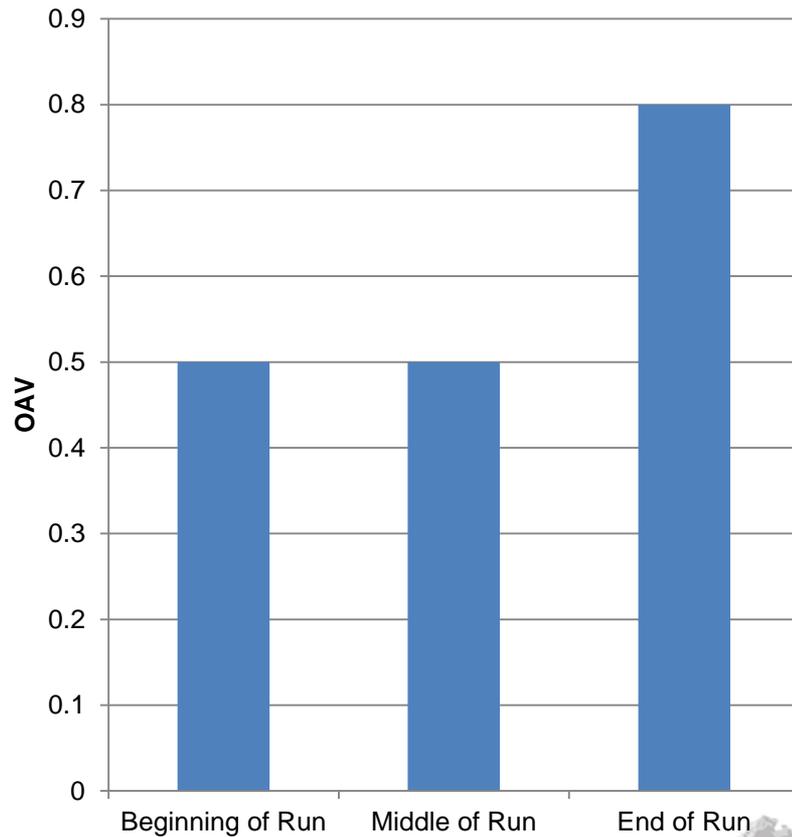
This beer had insufficient oak impact, so we tried mixing the tank.



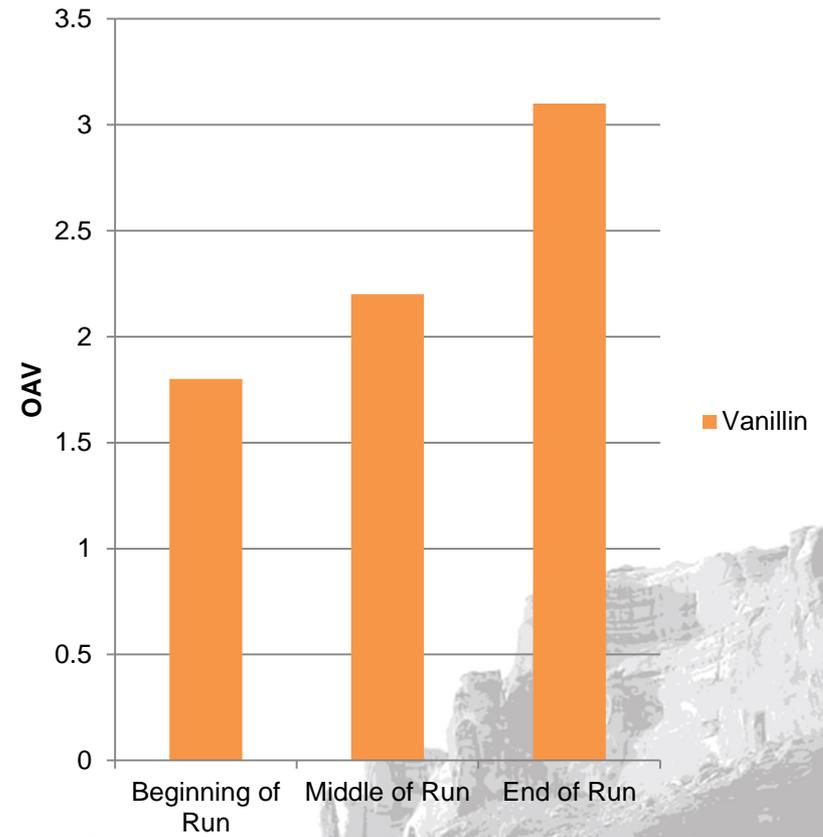


Pre-Mixing

cis-Lactone



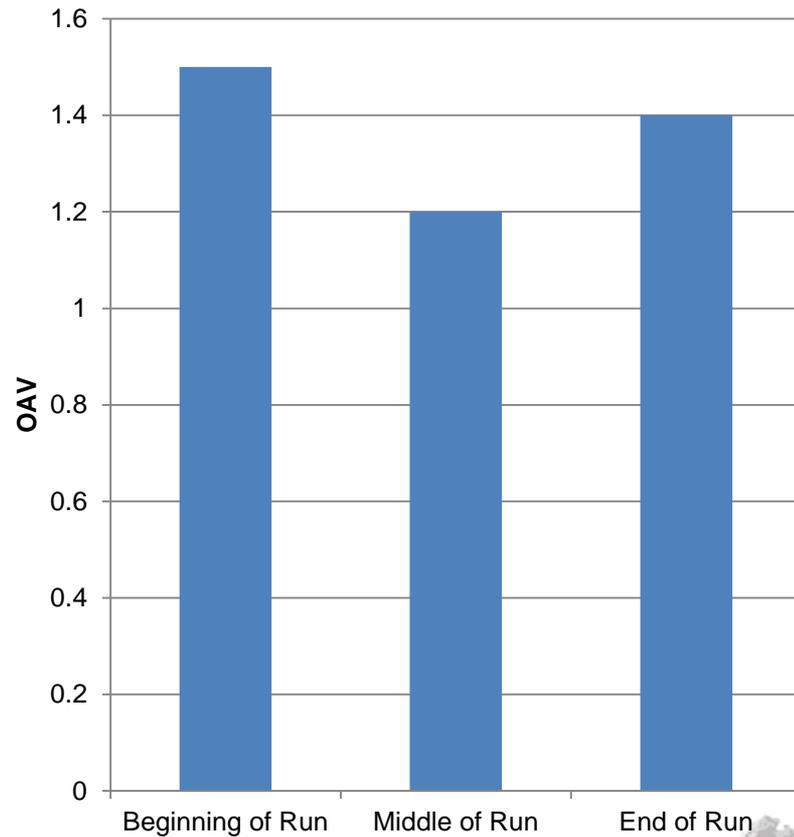
Vanillin



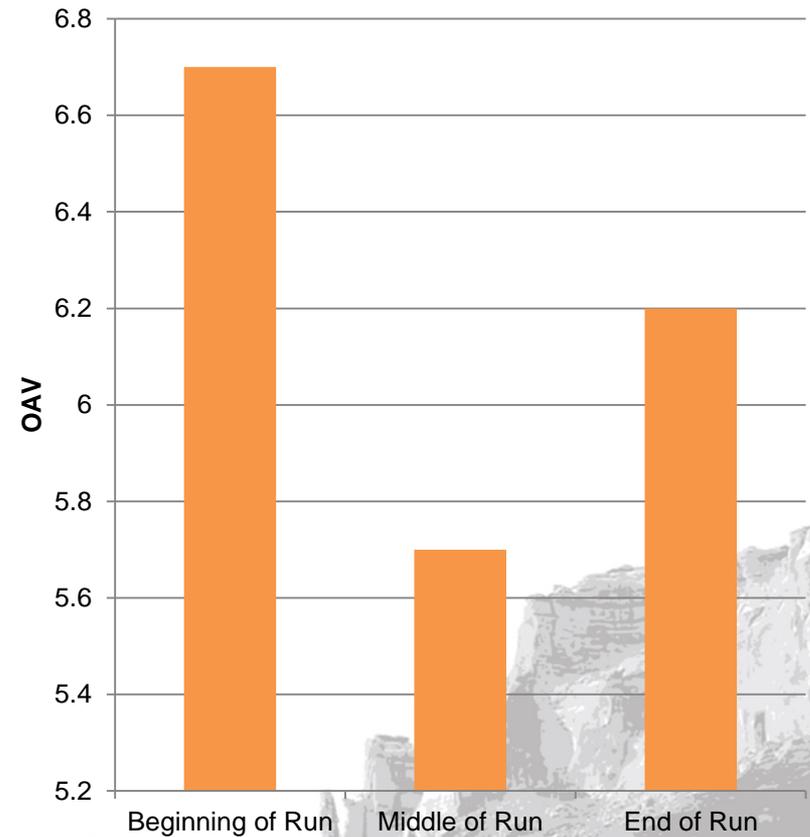


Post Mixing

cis-Lactone



Vanillin





What About Tannins?

Typically a nutty, non-hop bitterness, and will contribute mouthfeel.

Biofine clear works great to reduce!

Will polymerize over time and be more smooth.





Spirit Flavor Impact

Bourbon legal limit of 125 Proof to barrels for aging has a significant flavor impact if the barrels are fresh enough.





Next Steps

Stone Imperial Russian Stout aged in New Hungarian Oak Wine Barrels for Comparison

Will be monitored quarterly using this method!

Fusel monitoring? Maybe.





Questions?

“I am the clue-finder.... and I am Barrel-rider.”

Bilbo Baggins to
Smaug the Dragon
The Hobbit
J.R.R. Tolkein



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