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Difference in bubble formation using deep stops is dependent on length of bottom time;

Experimental findings and Theoretical support

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Background

- Deep decompression stops compared to more conventional shallower stops have recently been introduced in decompression

- Most findings and theoretical work on excess gas phase models suggest an apparent advantage of using deeper stops

- However, some reports indicate that the incidence and/or risk of decompression sickness (DCS) may actually increase following such procedures (Blatteau et. al. 2005)

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Deep stops

- Conventional supersaturation models like those developed by US Navy and Bühlmann are generally known for having relatively shallow decompression stops
- The concept of “deep stops” was born when divers reported a significant benefit by adding deeper stops to these conventional procedures
- The benefit of deep stops has later been supported by more advanced 2-phase models
- In practice those approaches are not very different

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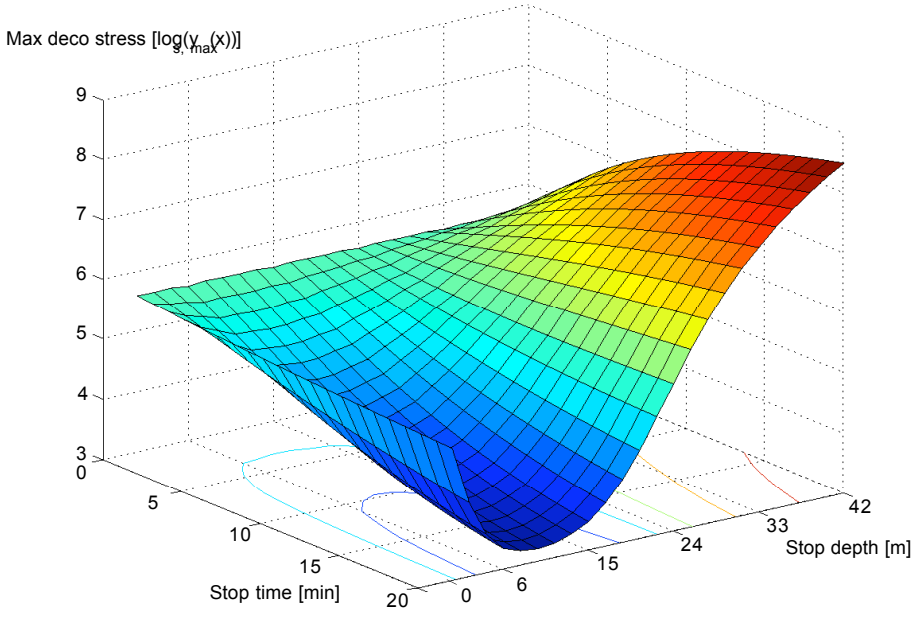
Deep stops in theory

- Compromise between effective gas elimination and low supersaturation to minimize bubble formation



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Experimental setup

- Pig model, dry chamber
- Ultrasonic imaging
- 26 pigs in total, groups: 4 x 6pigs + 1 x 2 pigs

30 msw / 70 min dive

Depth [msw]	Bühlmann	DS1
9m	-	14
6m	22	21
3m	47	25
Total deco	69	60

65 msw / 20 min dive

Depth [msw]	Bühlmann	DS2	SS2
12m	2	1	-
9m	5	9	-
6m	9	13	9
3m	27	15	33
Total deco	43	38	42

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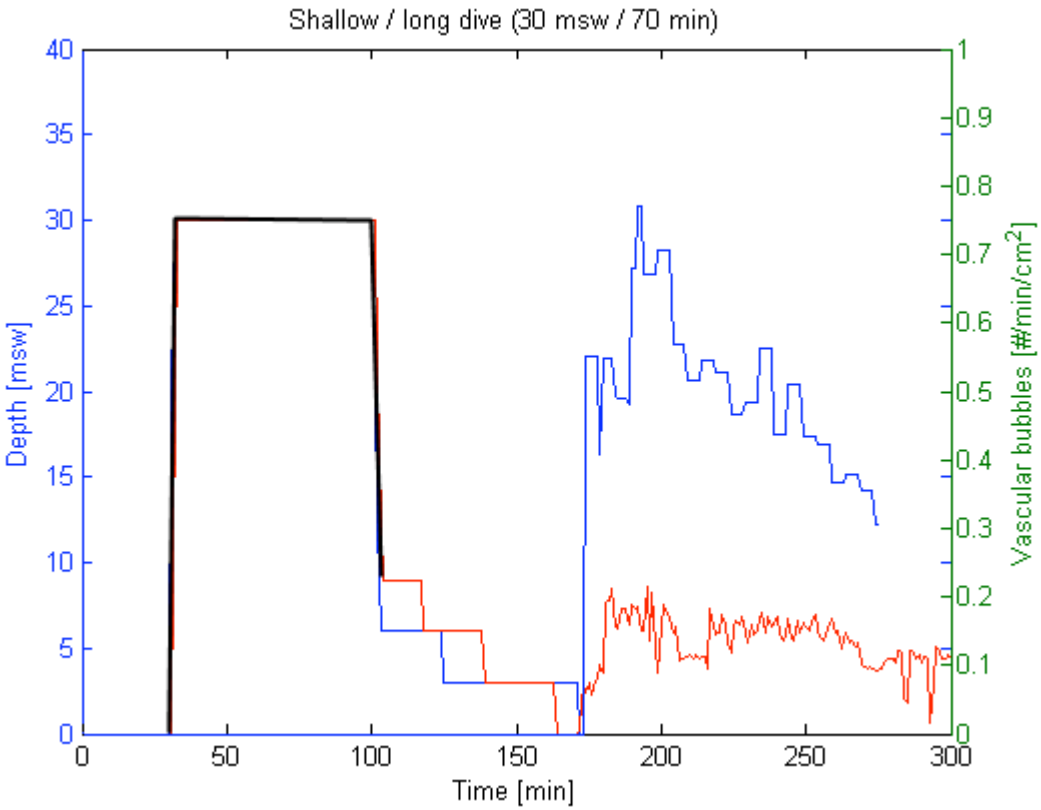
Results



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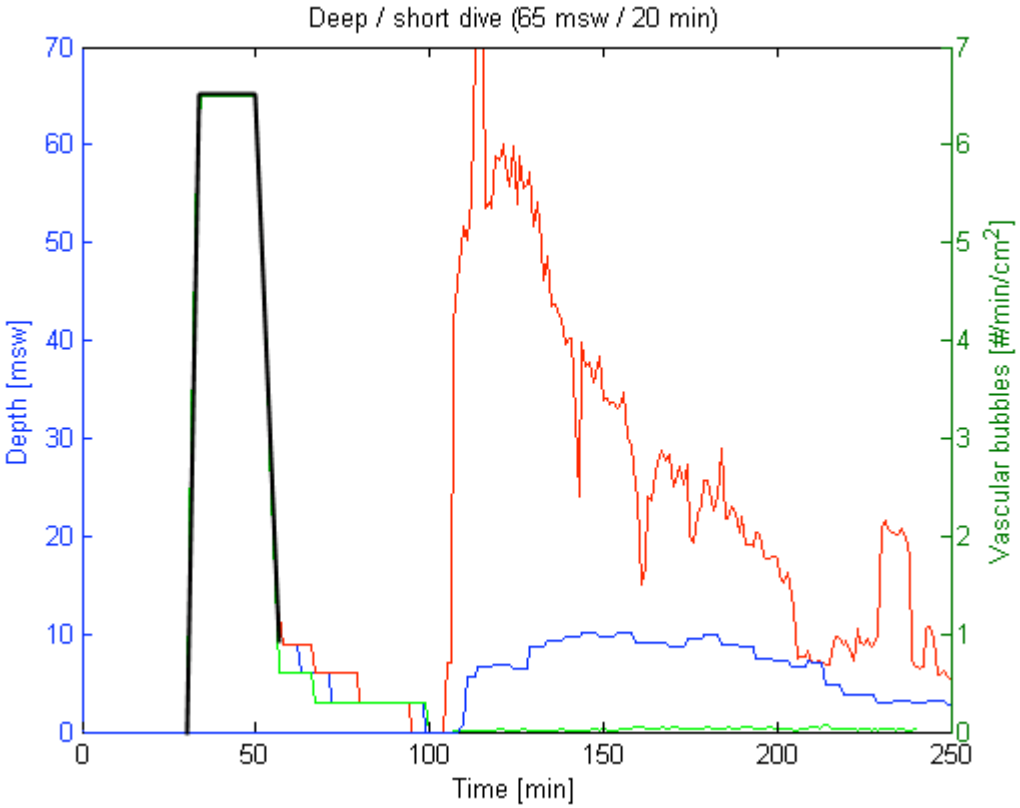
Results



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Effect of bubble nuclei

- Most 2-phase models consider an initial bubble size of a single bubble or a distribution
- If such a model is fitted to show the benefit of deep stops, it can not predict our contradictory results
- There must be an additional effect

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Stabilizing function

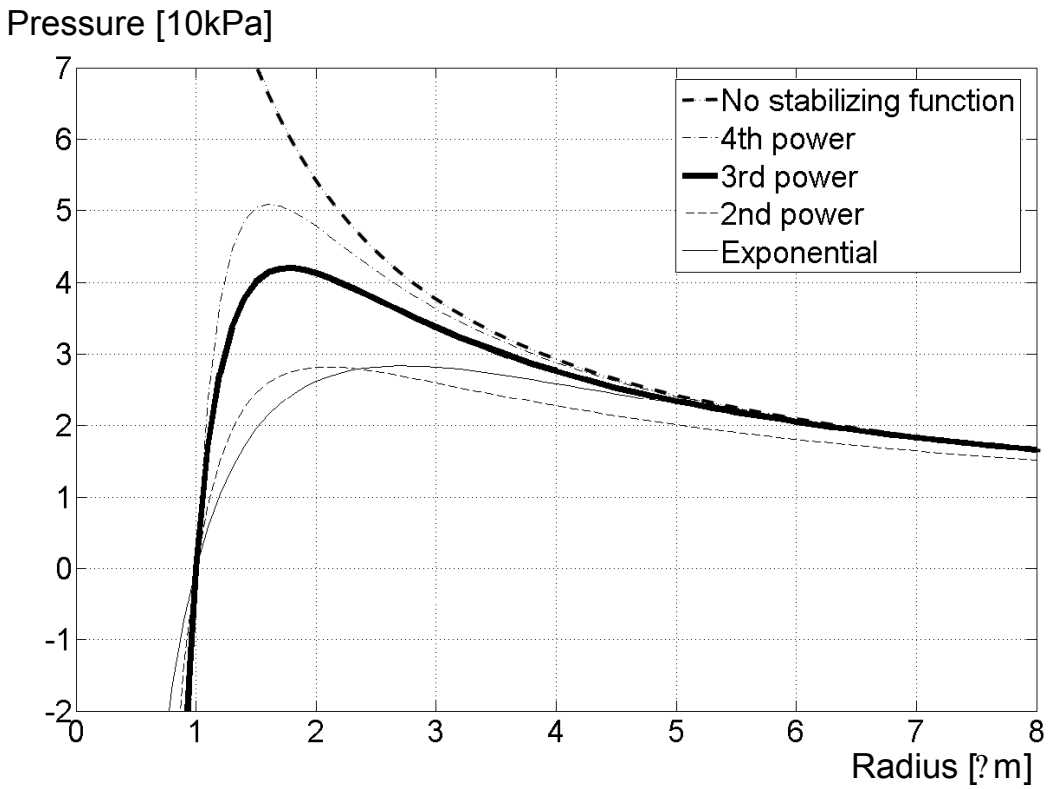
- Under normabaric, desaturated conditions, any bubbles in the body will, according to traditional bubble theory, shrink due to surface tension:

$$P_b = P_{amb} + \frac{2\gamma}{r}$$

- For any bubble nuclei to exist there has to be a stabilizing force opposing the surface tension

$$\Gamma(r, P_{amb}) + P_b = P_{amb} + \frac{2\gamma}{r}$$

Stabilizing function candidates



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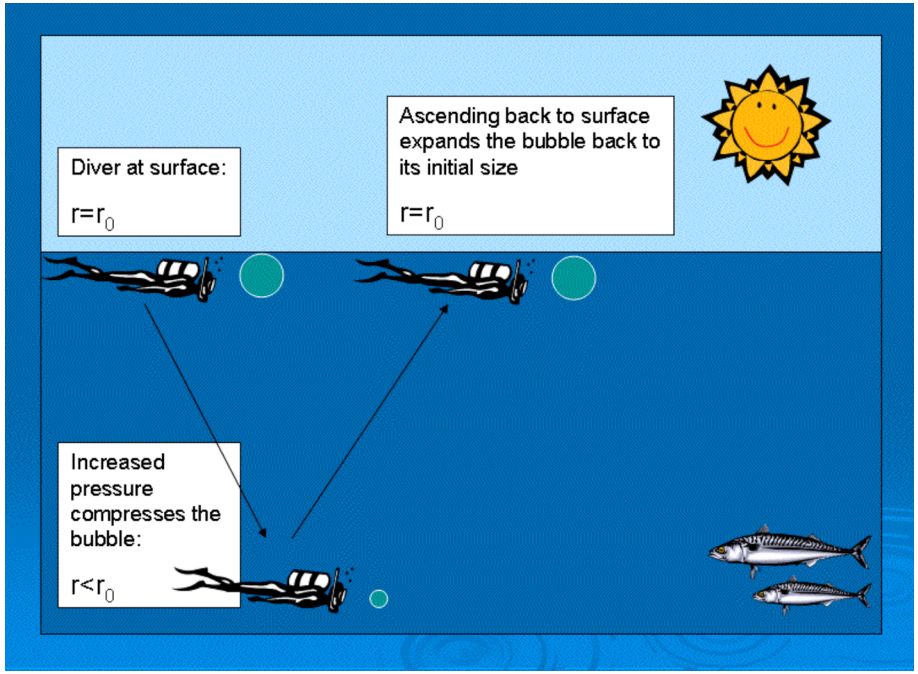
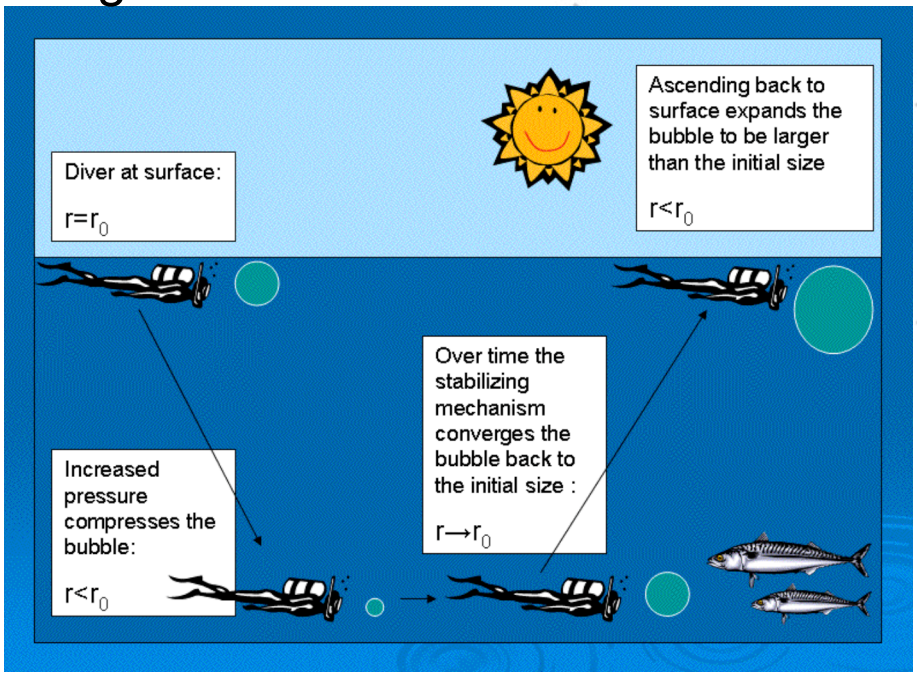
Bubble nuclei regeneration

Short dive



Long dive



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Conclusions

- A new stabilizing mechanism for bubble nuclei had to be developed in order to simulate and reproduce the findings in this study
- “Traditional bubble models” will in general suggest that adding some deep stops is beneficial for decompression outcome, however this may not always be true
- The presented studies suggest that deep stops are *not recommended* on:
  - Shorter dives and/or dives with very low activity
- Deep stops seem to still be beneficial on:
  - Longer dives
  - High-activity dives
  - Altitude exposures

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