INTRODUCTION:
Osteoporotic patients, smokers and diabetics are among those who represent higher risks with regard to bone formation. In these clinical situations where bone regeneration can be especially difficult there is a need for an active agent or material which can stimulate osteoblasts in addition to providing a scaffold for growth. Extensive research has been performed on silicon and calcium containing glasses, especially 45S5S, because of their potential for osteostimulation [1-3]. Upon implantation bioactivity is initiated by the release of soluble ionic species including Si\textsuperscript{4+}, Ca\textsuperscript{2+} and Na\textsuperscript{+} into the surrounding aqueous environment [1]. A series of reactions then leads to the deposition of a hydroxyapatite apatite layer (HCA) on the glass surface which creates an ideal site for osteoblast attachment [1]. In addition, numerous studies have shown that the dissolution products of 45S5 increase osteoblast differentiation and proliferation [1-3]. Various forms of bioactive glass have been in clinical use for over 20 years [1]. The glass itself, however, is not an ideal scaffold due to the lack of porosity and adequate handling characteristics.

Vitoss\textsuperscript{®} Foam Bone Graft Substitute (Orthovita, Inc.) (VT) is a composite of β-TCP and bovine Type I collagen. Vitoss Bioactive Foam (BA) is a similar composite with the addition of a proprietary 45S5 bioactive glass. The present study investigates VT and BA in a canine metaphyseal defect to compare the rates of healing.

METHODS:
VT and BA were implanted into contralateral drill-hole defects in the cancellous bone of the proximo-lateral humeri of 18 skeletally mature canines. Defects measuring approximately 10mm in diameter and 25mm in depth were created using a low speed drill, under constant irrigation. Four (4) animals were euthanized at 3, 6, 12, and 24 weeks and 2 animals were euthanized at 52 weeks. Histology slides were prepared by Charles River Laboratories, Montreal. Histomorphometric analyses were performed on Hematoxylin and Eosin (H&E) stained slides (n=4 per group) using a Spot camera (Model 2.2.0) and Image Pro Plus 5.1 software. Color based digital thresholding was used to quantify the percent area of remaining scaffold and new bone within the defect. Two independent operators performed these measurements at each time point and the averaged results are presented. An additional histology slide from each sample was left unstained for analysis by scanning electron microscopy (SEM).

Orthogonal cross-sections (~10mm in thickness) were cut from each defect site. A circular indenter with a diameter of 5mm was used to load the center of the defect site to failure at a constant displacement rate of 1mm/min [4]. An additional test was performed on un-operated cancellous bone adjacent to the defect site for comparison.

RESULTS:
Histomorphometry results indicate that most of the implant material in both groups was resorbed by 12 weeks and the percent area occupied by new bone in the defect site was in the range of that of adjacent cancellous bone (Figure 1). The progression of scaffold resorption and bone remodeling continued out to 24 weeks.

DISCUSSION:
This study demonstrates that Vitoss and Vitoss BA are biocompatible and support bone in-growth. Both materials showed a time-dependant progression of healing with the structure and stability of defect sites approaching those of native cancellous bone after 24 weeks.

The results of the mechanical indentation testing show that defect sites implanted with BA returned to native strength faster than defect sites implanted with VT. It is believed that this is related to the bridging capacity of the bioactive glass particles. As an osteoconductive material, β-TCP is very efficient in supporting the formation of bone, but the new bone growth does not typically extend a significant distance beyond the surface of the scaffold. In Vitoss BA, the bioactive glass induces bone growth by recruiting osteoblasts with ionic signals and creating a local environment that is favorable for new bone formation. This reaction extends the region of new bone growth and bridges the gaps between β-TCP scaffold morsels within the collagen matrix, thus creating a more interconnected trabecular network of new bone. The histology images in Figure 2 provide evidence of this theory. In both images new bone formation extends from the surface of the β-TCP scaffold to encapsulate reacted bioactive glass, and in the case of the BSE image on the left bone bridges are formed between morsels of β-TCP.

REFERENCES: